TF 2173

MARCONI
F1T2/SPR

TF 2173

Digital Synchronizer

INSTRUCTION MANUAL

MP MASTER
MA23637

mi
MARCONI INSTRUMENTS

RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.

H 54881-030D:C1

Digital Synchronizer
TF 2173

Model No. 52173-900M

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1977

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

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Note...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus ▶ ..... ◀ to show the extent of the change. When a chapter is reissued the triangles do not appear.

Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that the supply fuse is connected in series with the brown (live) wire of the supply lead. If the equipment is connected to the supply via a two-pin plug, it will be possible for the fuse to become connected to the neutral side depending upon the orientation of the plug in its socket. In these circumstances certain parts of the instrument could remain at supply potential even after the fuse has ruptured.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

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Chapter 1

GENERAL INFORMATION

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Fig. 1 Digital Synchronizer TF 2173 fitted to Signal Generator TF 2016

INTRODUCTION

1. Digital Synchronizer TF 2173 is designed for use with Signal Generator TF 2016. The two instruments are used jointly to produce a 10 kHz to 120 MHz signal generator system with high discrimination tuning and very good frequency stability.

2. The function of the synchronizer is to lock the signal generator to a high stability reference frequency. Digital frequency locking takes place over the whole of the signal generator bandwidth in increments of 10 Hz.

3. The selection and locking of the required frequency is extremely simple. Rotary frequency selection switches are set to give a lock frequency at a resolution of 10 Hz. The TF 2016 is then tuned to obtain a lock-on condition, indicated by the OUT OF LOCK lamp being extinguished.

4. Warm-up drift is eliminated and after a period of ten minutes an accuracy of 1 part in 10^6 (when measured over a period greater than 10 s) can be expected. All the generator facilities are fully maintained including the a.m. and f.m. facilities.

5. Switching facilities on the synchronizer allow the TF 2016 to be unlocked and used as an independent signal source. Provision is also made for obtaining an output from the internal 1 MHz standard or for accepting an input from an external 1 MHz standard.

PERFORMANCE DATA

6. Carrier

Range :	10 kHz to 119.99999 MHz (specifically for use with Signal Generator TF 2016).
Selection :	Seven decade switch controls in 10 Hz steps.
Incremental frequency control :	After synchronization, the decade controls may be used to digitally increment the genera- to carrier frequency over a range of typically 2% without retuning the generator.

7. Internal frequency standard

Ageing rate :	Not greater than ±1 in 10^7 per month after 3 months continuous use.
Temperature coefficient :	Not greater than ±1 in 10^7 frequency change over the range 0 to +40°C.
Warm-up time :	Typically 10 minutes for the frequency to be within 2 in 10^7 of final value.
Output level :	Not less than 2 V p-p square wave at 1 MHz.

8. RF input level — Compatible with TF 2016 counter output.

9. External standard input : Switched socket providing internally generated 1 MHz standard signal or accepting a 1 MHz input signal from an external standard. Maximum input 5 V p-p, minimum input 2.5 V p-p.

10. RF leakage : When used with TF 2016 and internal frequency standard, the r.f. leakage specificatio. the generator is not degraded.

11. Power requirements : AC supply. Any voltage within the limits 95 V to 132 V and 190 V to 264 V; 45 to 65 Hz (usable to 500 Hz).

Power consumption : 30 VA.

12. Dimensions and weight :

Height	Depth	Width	Weight
140 mm (5.5 in)	311 mm (12.25 in)	286 mm (11.25 in)	5.7 kg (12.5 lb)

ACCESSORIES

13. Supplied accessories

AC supply cable, 43129-071D.
Flexible screened coaxial cable, 50 Ω, BNC to BNC, 43129-063F.
Semi-rigid coaxial cable, 50 Ω, TNC to TNC, 43129-064G.
Protective front panel cover, 41690-102S.

14. Optional accessories

Carrying case, 41690-044B.

Chapter 2

OPERATION

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PREPARATION FOR USE

Note ...

1. Retain the container, packing materials and the packing instruction note (if included) in case it is necessary to reship the instrument. Repacking instructions are given in Chap. 4.

2. Before use, the instrument should be checked for any obvious physical damage which may have occurred during transit. The synchronizer may then be prepared for use as follows:-

Mains input

3. The instrument operates on 95 to 130 V or 190 to 264 V a.c. input ranges. These ranges are selected by removing the plate on the rear panel, setting the switch in its correct position and refitting the plate.

Fuse FS1

4. Check that the fuse is of the correct rating. Normally the instrument is supplied with a fuse rated at 160 mA (for voltage range 190 to 264 V a.c.). For voltages in the range 95 to 130 V change the fuse for one rated at 250 mA. In both cases the fuse fitted should be of the slow blow (time lag) type.

Supply cable

5. The a.c. mains cable is supplied with a connector which mates with the mains input connector on the rear panel. When fitting a suitable supply plug to the cable, ensure that the wires are connected to the plug as follows:-

Live - Brown
Neutral - Blue
Earth - Green/yellow

Fitting to Signal Generator TF 2016

6. If the synchronizer is to be used in conjunction with the TF 2016 in a semi-permanent role the two instruments may be fitted together as follows:-

(1) Position the TF 2016 on top of the synchronizer. Clamp the two instruments together using the clips attached to each side of the synchronizer case which locate into the latching plates fitted to the bottom of TF 2016.

(2) Using the *flexible* coaxial cable supplied, connect SYNC OUT on the synchronizer to SYNC/SWEEP IN on the TF 2016.

(3) Connect RF INPUT on the synchronizer to COUNTER OUT on the TF 2016 using the *semi-rigid* coaxial cable provided.

CONTROLS AND CONNECTORS

7. Front panel

(1) AC SUPPLY switch. Press up to switch ON. Lamp indicates rectified supply present.

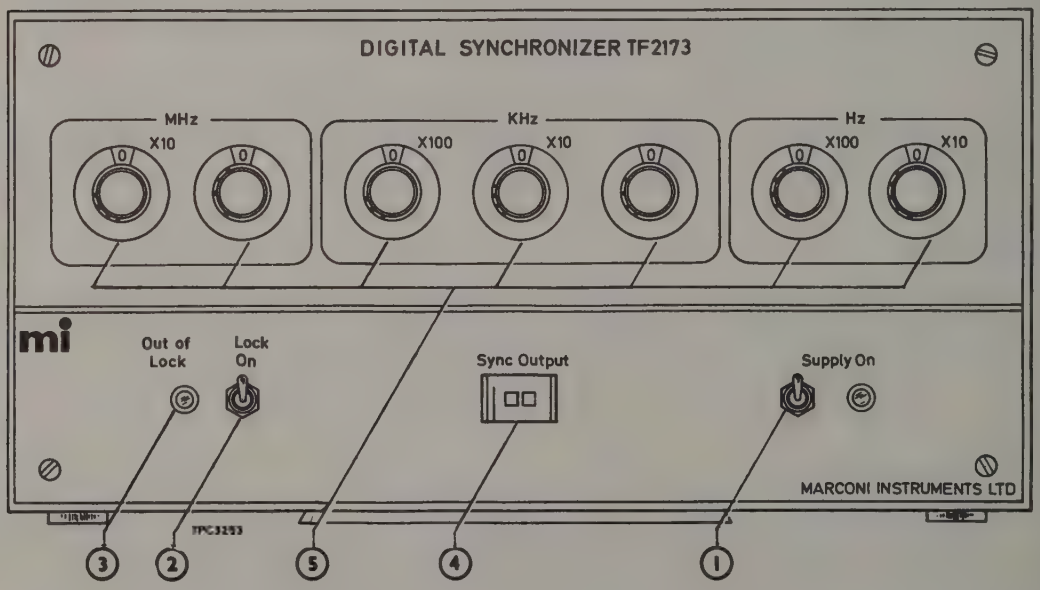

Fig. 1 Front panel

(2) LOCK ON switch. Press up to lock generator to synchronizer. In the down position the generator may be used independently of the synchronizer.

(3) OUT OF LOCK lamp. Goes out when the generator has achieved lock.

(4) SYNC OUTPUT meter. Indicates the control signal level of the synchronizer, i.e. the position of the generator frequency within the lock range.

(5) Frequency switches. Rotary decade switches set to select required frequency.

8. Rear panel

(1) AC input connector. Accepts the mains input cable 43129-071D.

(2) Voltage selector switch. Selects either the 95 to 130 V or 190 to 264 V a.c. ranges.

(3) Fuse. AC input fuse rated at 160 mA (slow blow) for 190 to 264 V or 250 mA (slow blow) for 95 to 130 V.

(4) RF INPUT connector (TNC 50 Ω). Accepts the COUNTER OUTPUT signal for the TF 2016.

(5) SYNC OUT connector (BNC 50 Ω). Carries the synchronizer control signal to the SYNC/SWEEP IN on the TF 2016.

(6) 1 MHz STANDARD connector (BNC 50 Ω). Connector for 1 MHz standard input or output dependent upon the setting of the 1 MHz STANDARD switch.

(7) 1 MHz STANDARD switch. Provides a 1 MHz STANDARD output when switched to INT OUTPUT. In the EXT INPUT position an external standard may be applied to replace the internal crystal standard.

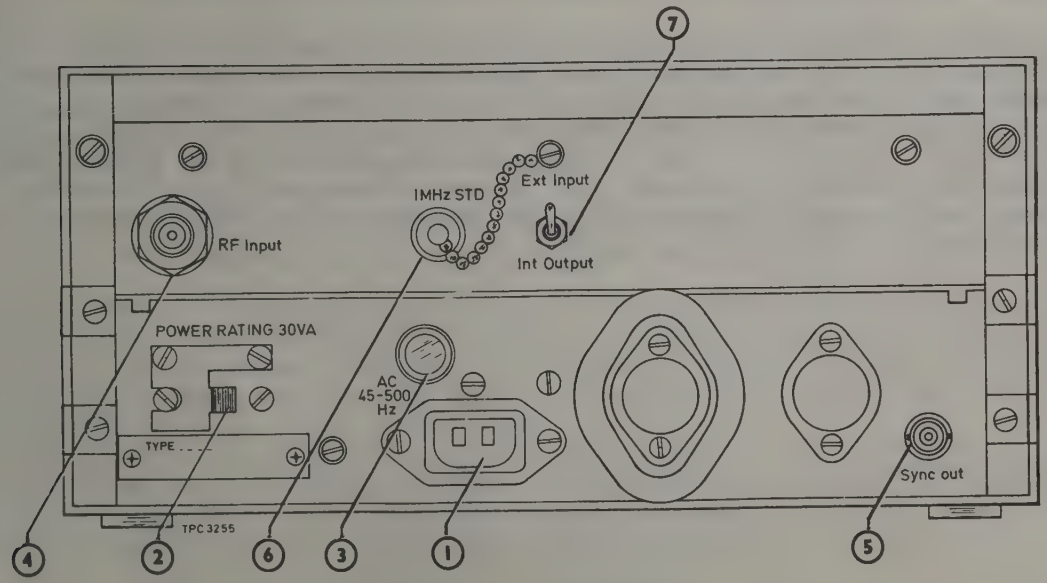

Fig. 2 Rear panel

OPERATING PROCEDURE

9. The setting up procedure is as follows:

(1) With both synchronizer and generator connected to the a.c. supply and switched on, check that both pilot lamps are lit.

(2) On the synchronizer, set the frequency switches as required and switch to LOCK ON.

(3) On the generator, set the function selector at CW and the CARRIER switch at ON. Select the appropriate carrier range and check that the pointer of the MOD & CARRIER LEVEL meter is within the white box on the meter scale.

(4) Using the TUNE control, and FINE TUNE control if necessary, carefully adjust the generator frequency to extinguish the OUT OF LOCK lamp on the synchronizer. Check that the pointer of the SYNC OUTPUT meter is stationary. It is advisable, particularly if the incremental frequency facility is to be used, to adjust the generator FINE controls to bring the pointer of the synchronizer SYNC OUTPUT meter to the centre of the white box.

Range of incremental frequency control

10. Once locked the carrier frequency may be controlled by rotating the digital control knobs on the front of the synchronizer. The extent of the frequency shift available before losing lock is limited by the loop gain and the control range of the synchronizer interface amplifier. In practise the maximum shift available varies between instruments and over each carrier frequency range. The typical maximum frequency swing obtained with several different units is shown by the shaded envelopes in Fig. 3. This diagram assumes that when the signal generator is initially locked the FINE TUNE control on the generator is adjusted to centre the pointer on the synchronizer meter. Although frequencies are shown for only three carrier ranges of the TF 2016 Generator similar results are to be expected on other ranges.

11. The FINE TUNE adjustment procedure above is not required for normal operation of the synchronizer at a fixed frequency; the meter position is of no significance once the OUT OF LOCK light is extinguished. However, to obtain a roughly symmetrical swing above and below the carrier frequency, the meter may be initially set to the centre using the generator FINE TUNE control. This adjustment alters the internal d.c. control voltage but not the carrier frequency:- the output frequency is always the same as the digital control knob settings.

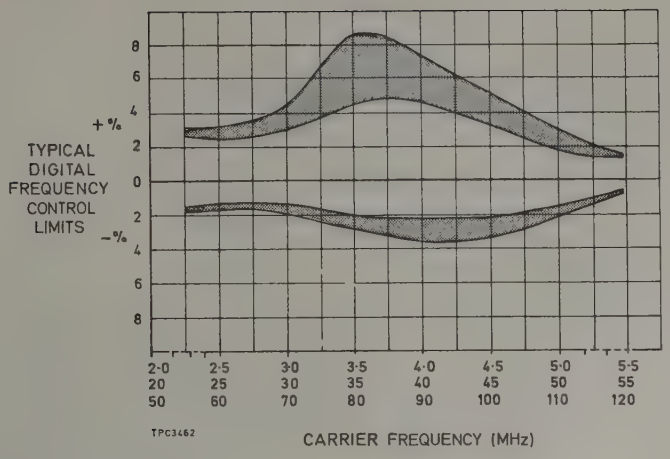

Fig. 3 Typical percentage detuning

FUNCTIONAL TESTS

12. The following tests describe the methods by which the instrument may be functionally tested. They are only intended as self-checking procedures to prove the general serviceability of the instrument.

13. With the mains input selector set to the correct setting for the local supply and a fuse fitted of the correct rating, switch on and observe that the supply lamp glows.

14. Connect the synchronizer to the TF 2016. Set the generator controls to give any frequency output in any mode. Select the frequency on the synchronizer and switch to LOCK ON. Adjust the generator tuning controls to extinguish the OUT OF LOCK lamp. The signal generator is now locked to the synchronizer and the SYNC OUTPUT meter should give a steady indication.

15. Use the tuning controls on the generator to centre the SYNC OUTPUT meter. Check that incremental frequency changes may be made up to 0.5% of the selected frequency by moving the synchronizer decade switches only. These changes should give a valid output despite changes in the SYNC OUTPUT meter provided that the OUT OF LOCK lamp remains unlit.

16. Setting the LOCK switch off (down position) will enable the TF 2016 to be used independently. The OUT OF LOCK lamp should now be lit.

17. Connect a frequency counter to the 1 MHz STANDARD connector and switch the 1 MHz STANDARD switch to INT OUTPUT. Check that the counter reads 1 MHz ±1 Hz. If an external standard is available connect it to the 1 MHz STANDARD input connector, switch to EXT INPUT and ensure that frequency lock may be achieved as normal.

18. Before putting the synchronizer into use ensure that the 1 MHz STANDARD switch is returned to INT OUTPUT. This will ensure that the internal standard is being used and a false lock condition avoided.

Chapter 3

TECHNICAL DESCRIPTION

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INTRODUCTION

1. The following description should be read in conjunction with the block diagram, Fig. 1, and the circuit diagrams in Chap. 7. The circuit is summarized in paras. 2 to 12 and the individual boards described in paras. 13 to 46.

CIRCUIT SUMMARY

2. RF input from Signal Generator TF 2016 is divided by a ratio set by the synchronizer dials and then compared with a standard frequency in a phase detector. The output from the phase detector is returned to the signal generator tuning control line and corrects any frequency drift.

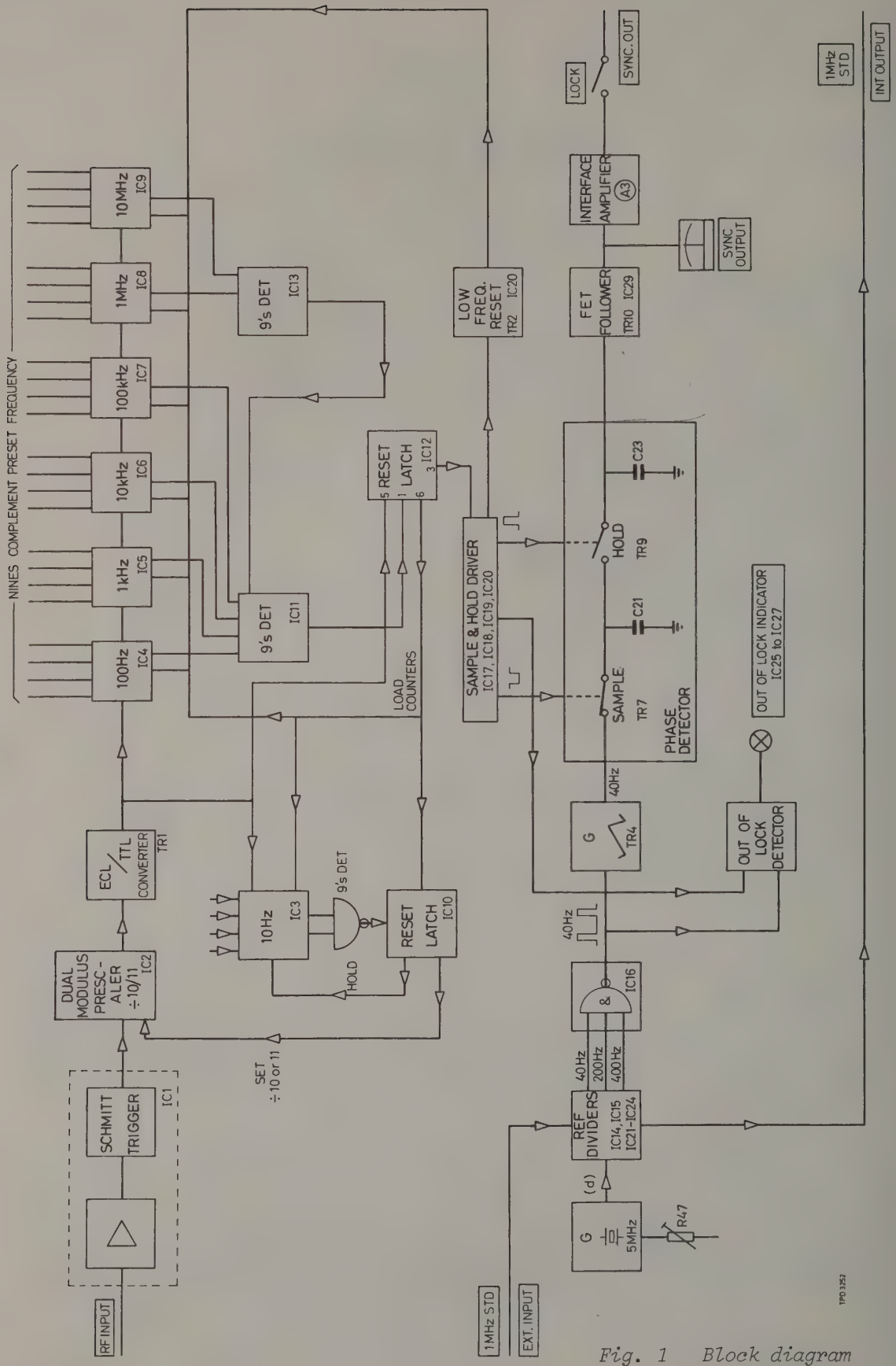

Fig. 1 Block diagram

3. Input amplifier. After amplification, IC1 improves the rise time of the signal. This enables the variable modulus prescaler IC2, which is an edge triggered device, to work down to 10 kHz.

4. Variable modulus prescaler and e.c.l./t.t.l. converter. This circuit carries out the 10 Hz increments division and conversion to t.t.l. logic. It is controlled by programmable counter IC3. The count cycle is 11 until the 10 Hz count is complete; it is then programmed to divide by 10 for the remainder of the count.

5. Programmable counters (v.r.d.). Each counter operates over one decade, counting in 9's complement form, i.e. with input 3 the counter sets to 6, with input 4 the counter sets to 5, and so forth. When all counts are complete, the 9's detector operates reset latch IC12 and the count is restarted.

6. Sample and hold driver. This circuit consists of four bistables, three of which are used to produce gating pulses for the sample and hold phase detector. The two pulses are in antiphase and of differing width and timed so that one lies within the period of the other. The pulse width of the sampling pulse is roughly one and a half times wider than the holding pulse. The remaining bistable provides a reset circuit in the event of a change in frequency selection part way through a counting cycle.

7. Reference oscillator. A 5 MHz crystal controlled oscillator provides the reference frequency for the sample and hold circuits. Its frequency may be adjusted by a fine control R47, or a coarse mechanical trimmer, when referred to an external standard of higher accuracy. By switching to EXT INPUT an external input of 1 MHz may be used as a standard. With this switch in the INT OUTPUT position a 1 MHz output derived from the reference oscillator is available at the 1 MHz STANDARD socket.

8. Reference divider and pulse gating circuit. The divider consists of six IC's arranged to divide the reference frequency by 125×10^3. Outputs of 40 Hz, 200 Hz and 400 Hz are gated together to provide 1 ms pulses at 40 Hz to drive the sample and hold ramp generator and the OUT OF LOCK circuit.

9. Ramp generator. The 1 ms pulses from IC16 cause a capacitor to be discharged and recharged through a constant current source. The recharging of the capacitor provides a 25 ms ramp. This ramp is fed to the sample and hold circuits.

10. Sample and hold phase detector. The sample and hold gates are operated by the outputs of the driver. Driver pulses open the sample gate and close the hold gate. While the sample gate is closed C21 continuously samples the incoming ramp. A pulse from the driver opens the sample gate and the voltage on C21 is frozen. After a slight delay the hold gate closes and this frozen sample charges C23. If the ramp and drive pulses remain in phase the d.c. voltage fed to the interface amplifier remains constant. A change in signal generator frequency results in a change in ramp sample point and a resulting change in voltage as shown in Fig. 2.

11. Interface amplifier (A3). This amplifier provides a current drive for the varactor diodes in the signal generator from the voltage across C23. The amplifier also corrects for gain changes in the feedback loop caused by the non-linear response of the signal generator varactor.

12. Power supplies. Voltages of +24, +12, +5 and -12 V are provided. All these outputs are regulated.

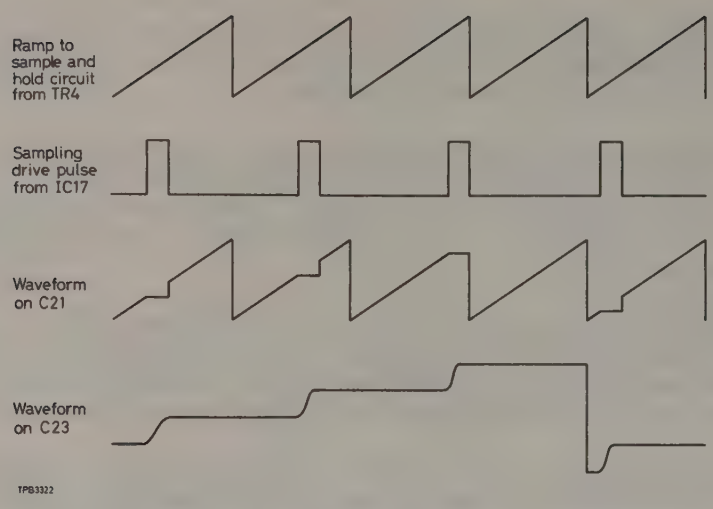

Fig. 2 Phase detector sampling and ramp waveforms

SYNCHRONIZER BOARD A2

Circuit diagram : Chap. 7, Fig. 2

Input amplifier and shaper (IC1)

13. The input from Signal Generator TF 2016 is amplified by the first two sections of IC1. Both stages have a gain of approximately 16 and are arranged in cascade. The third stage of IC1 is wired as a Schmitt trigger. This trigger shortens the rise time of the signal and in doing so lowers the working frequency of the dual modulus prescaler. R9 provides adjustment of the Schmitt trigger to ensure reliable operation at the extremes of the input frequency range.

14. TR11, diodes D11 to D17, capacitors C41 and C42 form a high frequency filter. When switches SF and SG are at zero, that is selecting a frequency below 1 MHz, diodes D11 to D15 will all be high. TR11 conducts and current drawn will enable D17 to conduct. C41 and C42 are then connected to the input circuit of IC1 and will filter any unwanted high frequency jitter. When a selection other than zero on either switches SF or SG is made, at least one of the diodes D11 to D15 conduct. TR11 and D17 cut off, isolating C41 and C42 from the input of IC1.

Dual modulus prescaler (IC2) and variable ratio dividers (IC3 to IC9)

15. To provide the variable ratio dividers with a frequency within their range (maximum 50 MHz) the input is prescaled or divided down and also, because this prescaler is an e.c.l. device its output is converted to t.t.l. levels.

16. Ideally the counters should be operated at the highest speed possible to enable rapid locking of the selected TF 2016 frequency. The counter speed, however, is limited by its reset time and with the presettable counters used a reset pulse width of 30 ns is required. This, coupled with the finite delay incurred during reset, would produce errors at high clock rates. IC2 can be instructed to divide by 10 or 11 at any time up to half way through its count cycle, so allowing a time of approximately five times that of the input clock period to be used.

17. IC3 to IC9 are nines complement ratio dividers controlled by b.c.d. logic derived from the frequency selector switches SA to SG. IC3 to IC8 count up to nine whilst IC9 counts to eleven. When all counters are full their outputs at pins 5, 6 and 12 are fed to the nines detector IC11 and 13. IC2 divides by 11 only until the 10 Hz count of IC3 is complete.

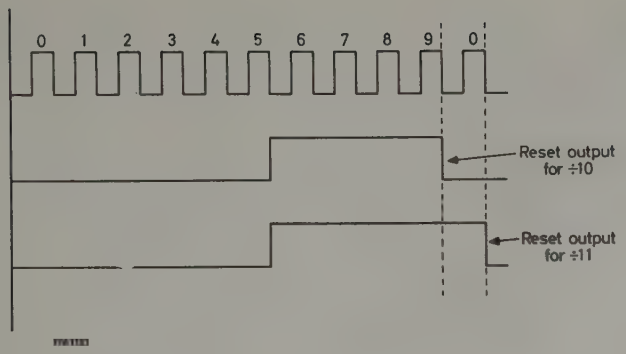

Fig. 3 Reset pulse operation

18. At this time IC3 outputs at pins 5, 6 and 12 operate reset latch IC10. IC10 pin 11 resets IC2 to divide by 10 and instructs IC3 to stop counting. IC4 to IC9 continue the count until the nines detector is activated. IC11 pin 8 operates reset latch IC12 which in turn performs three functions:-

(1) IC12 pin 3 provides pulses for the sample and hold circuit.

(2) IC12 pin 6 instructs IC2 to return to divide by 11, and

(3) Sets a '1' at IC3 pin 1 to reload all counters to their input information.

Principle of v.r.d. operation

19. The function of the VRD is to produce a pulse output with a p.r.f. of 10 Hz when the frequency selector controls are set to the value of the input frequency from the signal generator.

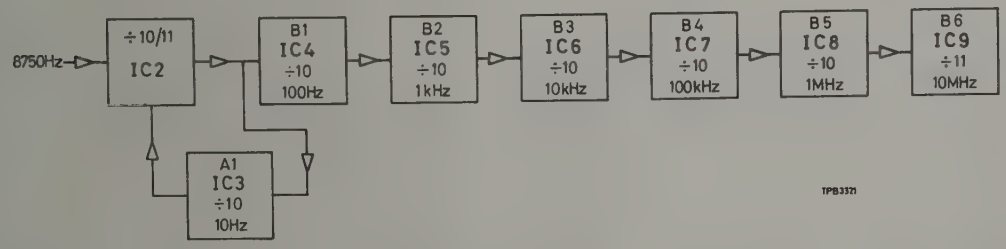

Fig. 4 VRD operation

20. The general expression for the division ratio, N, of such a v.r.d. is

$$N = 11(A1) + 10\ (B1 + 10B2 + 10^2B3 + 10^3B4 + 10^4B5 + 10^5B6 - A1)$$

where A1,B2,B3 etc. represent the initial settings of the 10 Hz, 100 Hz, 1 kHz etc. decades of the frequency selector.

21. If, for example, the frequency selector is set to 8750 Hz,

then A1 = 5
B1 = 7
B2 = 8
B3, B4, B5, B6 = 0

$\therefore$ N = 11 x 5 + 10 (7 + 10 x 8 - 5)
= 55 + 820
= 875

22. The v.r.d. therefore converts an input frequency of 8750 Hz to one of 10 Hz, i.e. pulses at 100 ms intervals. Any subsequent shift of input frequency causes the interval between output pulses to change, which initiates the appropriate change in control voltage.

23. In practice the v.r.d. stages operate in the 9's complement mode, i.e. by counting up from the 9's complement of the setting of the frequency selector. In the above example of 8750 Hz, the 9's complements are as follows:-

10 Hz counter	9 - 5 = 4
100 Hz counter	9 - 7 = 2
1 kHz counter	9 - 8 = 1
All other counters	9 - 0 = 9

The action of counting by the two lowest counters is shown below.

24.

		IC3 :10 Hz	*IC4 :100 Hz*
(1)	Initial b.c.d. 9's complement setting	4	2
(2)	After 11 input pulses to prescaler	4 advances to 5	2 advances to 3
(3)	" 22 " " " "	5 " " 6	3 " " 4
(4)	" 33 " " " "	6 " " 7	4 " " 5
(5)	" 44 " " " "	7 " " 8	5 " " 6
(6)	" 55 " " " "	8 " " 9 (full)	6 " " 7

At this point the 10 Hz counter is full and initiates a reset pulse through IC10 to reset prescaler to divide now by 10.

(7)	After 65 input pulses to prescaler	9 (full)	7 advances to 8
(8)	" 75 " " " "	9 (full)	8 " " 9 (full)

25. After each subsequent 100 pulses IC5, the 1 kHz counter (initially set at 1) advances by 1 and therefore reaches 9 after a total of 875 input pulses. The 9's detectors IC11 and 13 are then activated, which reset latch IC12, and the cycle restarts.

Sample and hold driver (IC17 to IC20)

26. These IC's are monostable devices with Schmitt trigger inputs. Their output pulse duration is determined by choice of timing components across pins 10 and 11. The sample and hold pulses from IC17 and IC19 are in anti-

phase and of approximately 1.5:1 pulse width ratio i.e. if IC17 pin 6 is 0.7 ms then IC19 pin 1 will be 0.45 ms (see Chap. 5, Fig. 3j). IC18 and IC19 provide pulses to the out-of-lock indicator circuit IC25 to IC27.

27. IC20 provides a kick reset facility in the event of the generator output and the v.r.d. program being incompatible. This may occur upon selecting a low frequency output on the generator and synchronizer after a high frequency count; if the 'load counters' instruction (IC12 pin 6) has yet to be received, e.g. count of 100 MHz changed to 10 kHz, the v.r.d's will continue counting to 100 MHz until the full count is complete. Driven by a low frequency input this count would take an unacceptable time. IC20 senses missing or less frequent pulses and resets the counters to the lower frequency count.

Reference oscillator

28. This is a 5 MHz crystal controlled oscillator with temperature control. The frequency of the oscillator may be adjusted by two controls, one mechanical and one electrical. A mechanical trimmer on the body of the oscillator controls the coarse adjustment whilst fine adjustment is effected by R47. It should be noted, however, that incorrect adjustment of these controls will impair the accuracy of the signal generator while using the internal standard. The output is a square wave of approximately 5 V in amplitude.

Reference divider (IC14, 15 and IC21 to 24)

29. Division of the standard input is by 125×10^3. These dividers are wired to divide either by 2, 5 or 10, and the output may be of equal or unequal mark/space ratio, dependent upon the interconnection of the pins. Dividers IC14, 21, 23, 24, 22 and 15 divide by 10, 5, 5, 10, 5 and 10 respectively. The output from IC16 pin 8 consists of 1 ms pulses at 40 Hz. To achieve this, outputs of 400 Hz, 200 Hz and 40 Hz, of various mark/space ratios, are taken from IC15 and IC22 and gated in IC16.

Pulse gating circuit (IC16)

30. IC16 NANDS together the outputs of the reference divider and provides drive pulses to the ramp generator. The 1 ms pulses are derived as shown in Fig. 5 when divider outputs A, D and C are coincident.

Ramp generator (TR3 to TR5)

31. The 40 Hz pulses from IC16 drive the ramp generator switch TR3. TR3 switches on for the duration of each pulse. While TR3 is switched off C16 charges up via constant current source TR4. When TR3 switches on C16 is discharged and the ramp resets. The ramp therefore lasts for the period between 1 ms pulses, i.e. 25 ms. Emitter follower TR5 couples the ramp to the sampling gate TR7.

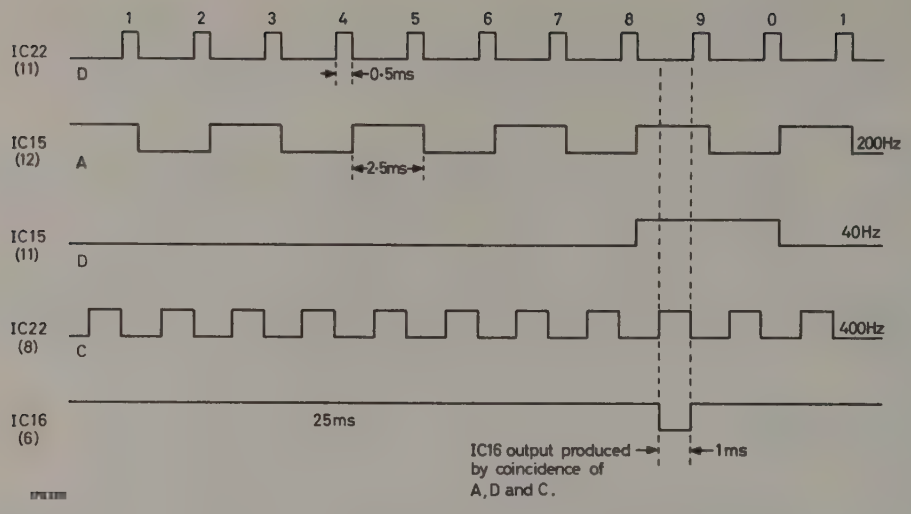

Fig. 5 Operation of IC16 pulse gating circuit

Sample and hold phase detector (TR7 to TR9)

32. Output pulses from IC17 drive TR6 which in turn switches TR7 on and off. TR8 and TR9 are similarly switched by pulses from IC19. With no pulse output from IC17, TR7 is switched on and the voltage across C21 follows the ramp voltage. On receipt of a pulse, TR7 switches off and TR9, driven by an inverse output, switches on. The instantaneous voltage of the ramp is thus held on C21. The switching on of TR9 lies within TR7 off time; therefore the output is isolated from the ramp. When TR9 switches on, the sampled voltage on C21 is transferred to C23. TR9 now switches off holding the sampled voltage on C23.

Synchronizer board output (TR10 and IC29)

33. TR10(1) is a f.e.t. follower providing the interface amplifier A3 with the control voltage from the sample and hold circuitry. To ensure that only changes in control voltage are passed to A3 TR10(1) is operated under stable conditions. TR10(2) provides a constant current source offsetting changes in supply whilst IC29 holds the drain source voltage below 9 V (approx.) to keep gate leakage current to a minimum.

Out-of-lock indicator circuit (IC25, 26, 27)

34. The out-of-lock indicator circuit detects all conditions in the digital circuitry that would result in failure to synchronize or synchronization at a false locking point.

35. It functions as shown in Fig. 6 by taking the 40 Hz ramp pulses from IC16, dividing them by four and then checking for coincidence with a v.r.d. output. If this condition is met a pulse is fed to the monostable IC28, triggers it and the l.e.d. indicator is then unlit. This continuous process results in the monostable being continually retriggered and the lamp remaining extinguished.

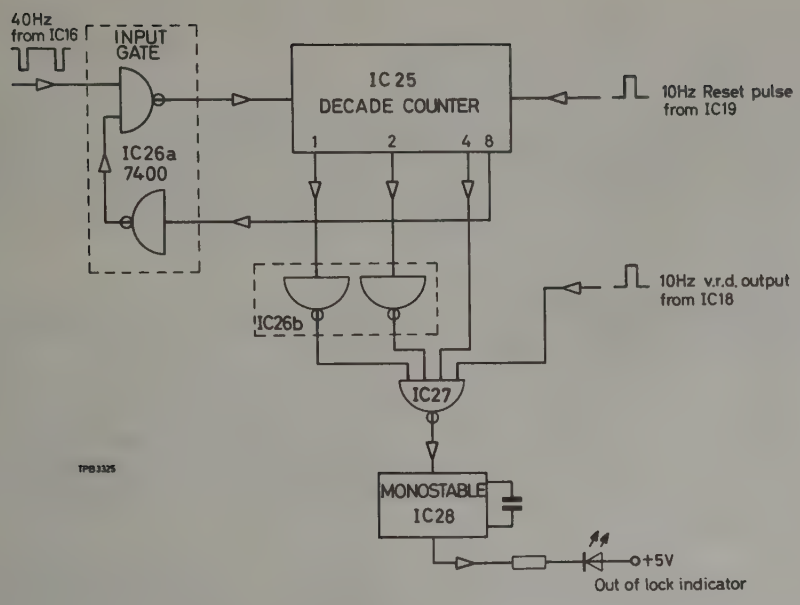

Fig. 6 Out-of-lock indicator circuit

36. The decade counter IC25 is initially set to zero by the last v.r.d. pulse and starts to count the ramp pulses from IC16. A decoding circuit is arranged to produce an output when IC25 has counted four pulses and at the same time looks for coincidence of this output with a v.r.d. output obtained from IC18.

37. Coincidence of these two signals is an indication of correct locking and the resultant pulse is used to trigger the monostable IC28 which causes the OUT OF LOCK lamp to be extinguished. Immediately following the pulse from IC18 a pulse is produced by IC19 and this will reset IC25 to zero so that the cycle can be repeated.

38. The circuit as described will be satisfactory for the following out-of-lock conditions:-

(i) Loss of 40 Hz pulses due to circuit failure or not applying an external standard when in external mode of operation.

(ii) Loss of v.r.d. pulses due to circuit failure or signal generator carrier being off, or the more usual condition of the signal generator being inadvertently set to the wrong frequency.

39. One special condition that could cause incorrect operation of the lamp is if the signal generator should be set at a certain frequency on the low side of that set on the synchronizer; whereupon the v.r.d. pulses appear not every four ramp pulses but every fourteen or twenty four and a trigger pulse will be produced. This condition is prevented by the input gate and its connection to pin 8 output of IC25.

40. This stops the ramp pulses reaching IC25 input if the v.r.d. pulse has not occurred by the time that eight ramp pulses have been counted. Correct operation of the circuit can be seen by the indicated pulses being present as illustrated in Chap. 5, Fig. 3n.

INTERFACE AMPLIFIER (BOARD A3)

Circuit diagram : Chap. 7, Fig. 1

41. The amplifier provides a current drive for the TF 2016 tuning circuits from the error voltage output of the synchronizer board A2. TR3 to TR6 form a long-tailed pair in which TR5 acts as a current inverter adding the current of TR6 to that of TR3. Temperature compensation is provided by diodes D3 and D4.

42. During setting up, the amplifier is balanced by R13 and R17. Their values are selected to give zero output current into a load split between supply rails and with the input connected to earth.

43. An l.e.d., D2, and light sensitive resistor, PCC1, are included to vary the gain of the interface amplifier so as to compensate for the non-linearity of the varactors in the TF 2016. The sensitivity of the varactors is low at the high end (maximum tuning voltage) and high at the low end (minimum tuning voltage) of each frequency range.

44. When the tuning voltage is high D2 remains unlit and PCC1 remains at high resistance. The pad formed by PCC1 and R6 has low attenuation and the amplifier gain is high for the low sensitivity region of the varactor. At the other end of the range when the tuning voltage is low, D2 is fully illuminated and PCC1 has a low resistance. This results in attenuation of the control signal to compensate for the high varactor sensitivity.

POWER SUPPLY (BOARD A4)

Circuit diagram : Chap. 7, Fig. 1

45. This power supply has regulated outputs of +24 V, +12 V, +5 V and -12 V. The circuits for +24 V, +12 V and +5 V are all of similar design. Single chip regulators are used for each of the supply rails.

46. The -12 V rail is regulated by IC1 and TR1. TR1 is in series with the output and is controlled by comparator IC1. IC1 compares a sampled voltage (junction of R5 and R6) of nominally 0 V with earth potential. This is detected by the comparator which, via the series regulating element TR1, returns the output voltage to -12 V.

47. Relay RL1 ensures that when the TF 2173 is switched off no interaction will affect the accuracy of the TF 2016 when operating independently.

Chapter 4

MAINTENANCE

CONTENTS

Para.
1 Introduction
4 Access and layout
5 Performance checks
7 Power supply A4
8 Frequency standard
9 Input amplifier
10 Ramp generator
11 Output f.e.t. current
12 Interface board A3
13 Overall checks
14 Cleaning rotary switches
15 Repacking instructions

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1 Test equipment 4

Fig. Page
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1a Filter box components 2
2 Top view - A2 hinged back 3

INTRODUCTION

1. This chapter contains information for keeping the equipment in good working order and for checking its overall performance. Before attempting any maintenance on the equipment you are advised to read Chap. 3, Technical Description.

Screw fasteners

2. The majority of screw threads used in this instrument are metric of various sizes but in some positions BA sizes are used. All chromium plated screws and all blue tinted screws are metric. Ensure that removed screws are refitted in their original positions.

Sensitive components

3. There are no static sensitive components fitted to this instrument but normal care should be exercised when handling IC's or transistors, particularly in the use of excessive heat. Before attempting continuity or insulation checks or before shorting or open circuiting a circuit, refer to the circuit diagram to establish the effect on the biasing of affected components.

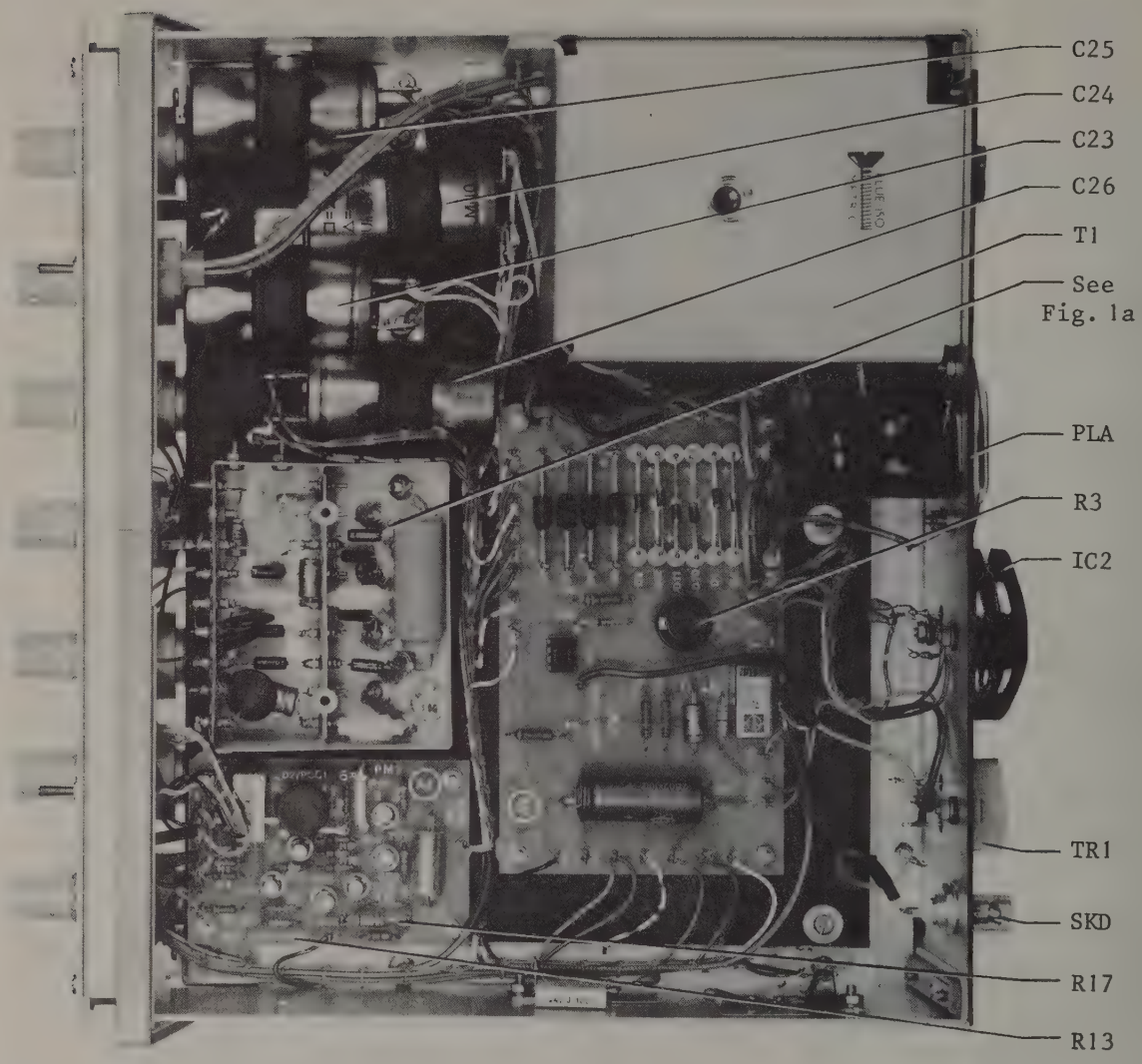

Fig. 1 Underside view

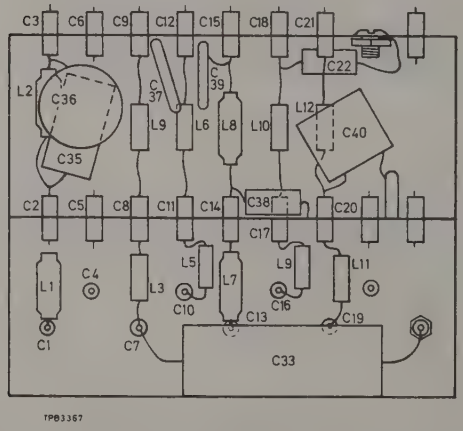

Fig. 1a Filter box components

ACCESS AND LAYOUT

4. The instrument is housed in a case which has top and bottom covers. These covers are removed by unscrewing six retaining screws (three each side). The case contains three sub-assemblies A2, A3 and A4. A3 and A4 are located on the underside of the instrument, A2 is located on the top after removing the r.f. box lid. A2 may be swung out to access its underside by removing the three retaining screws, loosening its pivot screws and lifting the rear of the board, taking care not to strain the cable harness.

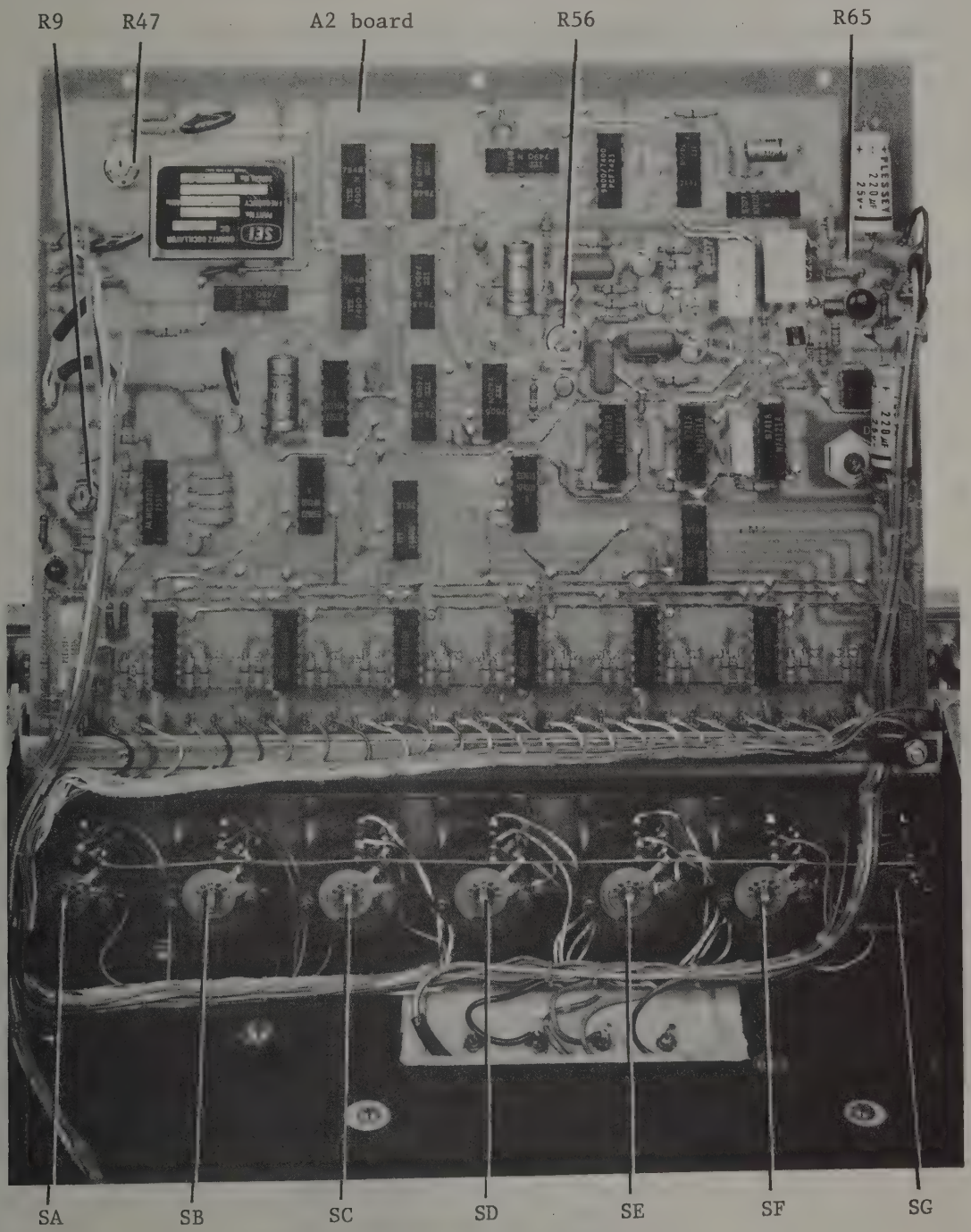

Fig. 2 Top view - A2 hinged back

PERFORMANCE CHECKS

Introduction

5. Many of the methods described in this section are simplified and of restricted range compared with those which would be required to demonstrate compliance with the specification. They should be regarded only as providing a check procedure for use during routine maintenance to determine whether adjustment or repair is necessary.

6. Performance limits quoted are for guidance only and should not be taken as guaranteed performance specifications unless they are also quoted in the performance data contained in Chap. 1. When making tests to verify that the equipment meets the guaranteed performance limits, allowance must always be made for the uncertainty of the test equipment used.

Note ...

If the results quoted in the following are not obtainable refer to the related section in Chap. 5.

TABLE 1 TEST EQUIPMENT

Item	*Description*	*Minimum use specifications*	*Recommended model*
a	Multimeter	Input resistance >20 kΩ/V Accuracy ±1.5% of f.s.d.	GEC Selectest
b	Differential d.c. voltmeter	Input resistance 1 MΩ nominal. Accuracy ±0.02% of reading ±100 μV. Voltage range 1 mV to 1100 V.	
c	Oscilloscope (dual trace)	Time base 10 ns/cm to 100 ms/cm ±5% with rise time >2 ns. Amplitude 0 to 25 V ±5%.	
d	x10 Oscilloscope probe		
e	Frequency counter	Frequency range greater than 120 MHz with resolution of 100, 10, 1 or 0.1 Hz. Accuracy ±1 count ± stability of frequency standard. Sensitivity 10 mV r.m.s. (sinewave).	MI TF 2432
f	Variable voltage transformer	Variable between 95 V to 264 V at 2 A.	Variac
g	2 x 47 kΩ resistors	¼ W ±2% tolerance.	
h	Signal generator	Freq. range 10 kHz to 120 MHz with facilities for SYNC/SWEEP IN, accepting a frequency sweep voltage from Digital Synchronizer TF 2173.	MI TF 2016

Power supply A4

Test equipment : items a, f.

7. To check the outputs from the power supply and the function of the stabilizers proceed as follows :-

(1) Disconnect the TF 2173 from the supply and remove the connections to pins 14, 15, 17 and 18.

(2) Connect the TF 2173 to the supply, switch on and check that 5.25 V d.c. appears across pin 18 (positive) and pin 8 (negative). If necessary adjust R3 to correct this voltage.

(3) Leave the negative lead of the multimeter connected to pin 8 and check that +24 V ±1 V and +12 V ±0.5 V appear on pins 14 and 17 respectively.

(4) Reconnect the multimeter positive lead to pin 8 and check that -12 V ±0.5 V appears on pin 15.

(5) Switch off the supply and reconnect the wires to pins 14, 15, 17 and 18. Switch on again and check that the voltages present are the same as those noted in paras. (3) and (4).

(6) With the supply to the instrument connected via the Variac, check that the outputs remain within ±100 mV for an input variation of 190 to 264 V (or 95 to 130 V).

Frequency standard

Test equipment : item e.

8. The frequency standard has been carefully set during manufacture and should not need frequent adjustment. If it becomes necessary to reset the standard proceed as follows:-

(1) Connect the frequency counter to the 1 MHz STANDARD output connector. Allow at least ten minutes for the oven to warm up.

(2) Adjust R47 to read 1 MHz ±0.5 Hz.

Input amplifier

Test equipment : item h.

9. Connect the TF 2016 to the synchronizer and set both to 10 kHz. Adjust R9 on A2 so that the meter needle of the synchronizer is steady and locked. Set both instruments to 119.9 MHz and adjust R9 again for a steady lock. Check the lock again at 10 kHz, adjusting R9 for the best compromise at both ends of the range. Extreme care must be taken to achieve a steady lock throughout the whole range of the instrument.

Ramp generator

Test equipment : item c.

10. To obtain a symmetrical ramp about 0 V (±7 to 8 V) connect the oscilloscope to the collector of TR3 and adjust R56 to give the waveform shown in Chap. 5, Fig. 3f. If necessary, R55 may be selected to extend the range of R56.

Output f.e.t. current

Test equipment : item a.

11. To set the current of the output f.e.t., TR10, disconnect the coaxial cable from pins 36 and 37. Connect the multimeter across R64 and select R65 to give a voltage drop of 50 to 60 mV across R64. Reconnect pins 36 and 37.

Interface board A3

Test equipment : items a, g.

12. Balance the output current of TR3 and TR6 as follows:-

(1) Disconnect the input to the amplifier by removing the coaxial lead to pin 9. Short out the input by connecting pin 9 to pin 8.

(2) Connect the two resistors (47 kΩ) across the +24 V, -12 V supplies (pins 1 and 5).

(3) Set the LOCK ON switch to ON and connect the multimeter, set to 1 mA f.s.d., between pin 2 and the centre point of the two resistors.

(4) Switch on the TF 2173 and, turning the meter range down to 50 µA f.s.d., measure the current drawn (reverse the meter connections if necessary). If the reading is zero the amplifier output is balanced.

(5) Should the current reading be greater or less than zero place a 220 kΩ resistor (±2% tol.) in either the R13 or R17 position. If the current increases place the resistor in the alternate position and select a resistance value which will reduce the current reading to zero.

(6) Remove the 47 kΩ resistors and the short from pins 9 and 8. Reconnect the coaxial cable to pin 9.

Overall checks

Test equipment : items c, d, h.

13. Carry out an overall check by measuring the waveforms shown in Chap. 5, Fig. 3. If the results are unsatisfactory refer to the fault location tables in Chap. 5.

CLEANING ROTARY SWITCHES

14. If it becomes necessary to clean the contacts of any rotary switches this should be done with benzine or white spirit (not carbon tetrachloride) and the contacts should afterwards be wiped with a suitable lubricant such as 1% solution of petroleum jelly in white spirit. Avoid lubricants containing soap or solid materials.

REPACKING INSTRUCTIONS

15. If the instrument is to be returned for servicing attach a label indicating the service required, type or model number (on rear label), serial number and your return address. Pack the instrument in accordance with the general instructions below or with the more detailed information in the packing instruction note.

(1) Place a pad in the bottom of the container.

(2) Place pads in the front and rear ends of the container with the plywood load spreader(s) facing inwards.

(3) Put the polythene cover over the instrument and place it in the container with the front handles and rear projections (where applicable) against the plywood load spreaders.

(4) Place pads in the two sides of the container with cushioning facing inwards.

(5) Place the top pad in position.

(6) Wrap the container in waterproof paper and secure with adhesive tape.

(7) Mark the package FRAGILE to encourage careful handling.

Note ...

If the original container or materials are not available, use a strong double-wall carton packed with a 7 to 10 cm layer of shock absorbing material around all sides of the instrument to hold it firmly. Protect the front panel controls with a plywood or cardboard load spreader; if the rear panel has guard plates or other projections a rear load spreader is also advisable.

Chapter 5

REPAIR

CONTENTS

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1 Introduction
4 Fault location
5 DC voltages
7 Interface amplifier
8 A2 Synchronized output check
9 Frequency reference divider check
10 Out-of-lock circuit check
11 Variable ratio dividers, dual modulus prescaler and e.c.l./t.t.l. converter check
13 Sample and hold drivers

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3 Frequency reference divider periods ... 4
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2 Fault finding chart ... 7
3 Typical waveforms ... 8

INTRODUCTION

1. This chapter is intended to assist in fault finding and repairing the instrument, and should be used in conjunction with the technical description, Chap. 3, and circuit diagrams, Chap. 7.

2. Integrated circuits and semiconductor devices are used throughout this instrument and although these have inherent long term reliability and mechanical ruggedness, they are susceptible to damage by overloading, reverse polarity and excessive heat or radiation. Avoid hazards such as prolonged soldering, strong r.f. fields or other forms of radiation and the use of insulation testers.

3. In case of difficulties which cannot be resolved with the aid of this book, please contact our service division at the address given on the rear cover, or your nearest Marconi Instruments representative. Always quote the

type and serial number found on the data plate at the rear of the instrument.

FAULT LOCATION

4. Some aid to fault finding is provided by the chart, table and sub-circuit checks included in this chapter. It is emphasized that a good working knowledge of the instrument must be achieved before attempting any sub-circuit or component replacement.

DC voltages

Test equipment : item a.

5. Voltages given on the circuit diagrams and in the following tables approximate those which can be expected using a 20 kΩ/V multimeter on a typical TF 2173 connected to a supply of 240 V a.c., 50 Hz.

TABLE 1 DC VOLTAGES

Test point	*Voltage*	*Remarks*
A2 Synchronizer board		
TR3 base	-7.8 V	
emitter	-8.0 V	
collector	0.75 V	
TR4 gate	0.65 V	
drain	12 V	
source	2.25 V	
TR5 base	0.75 V	
emitter	0.65 V	
collector	-12 V	
TR6 base	-11.5 V	
emitter	-12 V	
collector	10.6 V	
TR7 gate	0.27 V	
drain	0.95 V	
source	0.65 V	
TR8 base	-11.25 V	
emitter	-12 V	
collector	-12 V	
TR9 gate	-11.5 V	
drain	-	Varies according to a.c. conditions
source	0.95 V	
TR10 gate 1	-	Varies according to a.c. conditions
drain 1	9.5 V	
source 1	0.7 V	
gate 2	-	Varies according to a.c. conditions
drain 2	0.7 V	
source 2	-10.6 V	

TABLE 1 DC VOLTAGES continued

Test point	*Voltage*	*Remarks*
A3 Interface board		
TR1 base	0.55 V	
emitter	1.25 V	
collector	1.25 V	LOCK ON switch to off.
TR2 base	0 V	
emitter	0.55 V	
collector	0 V	
TR3 base	-	Varies with synchronizer 'range of lock setting'
emitter	-	
collector	19.5 V	
TR4 base	-9.3 V	
emitter	-10 V	
collector	-5 V	
TR5 base	19.5 V	
emitter	≈21 V	A very high input impedance measuring instrument should be used in lieu of (a) to prevent instability and voltage fluctuations.
collector	0.7 V	
TR6 base	0 V	
emitter	-0.5 V	
collector	0.7 V	

TABLE 2 POWER SUPPLY FAULTS

Fault	*Possible causes*
No SUPPLY ON indication	A0FS1, A0D1, A4R4 or +12 V supply
No +12 V supply (pin 17)	A0IC1 or A0T1
No -12 V supply (pin 15)	A0TR1, A4IC1, A4R1, A4R5/6 or A0T1
No +5 V supply (pin 18)	A4IC2 or A0T1
No 24 V supply (pin 14)	A4IC3 or A0T1
Incorrect supply levels	A0D1 to A0D12, A0C23 to A0C32
Incorrect +5 V supply	A4R2 or A4R3
Incorrect -12 V supply	A4IC1 offset components or +5 V supply

6. Further fault finding may be assisted by reference to Fig. 2.

A3 Interface amplifier check

7. Check the amplifier for output current balance as described in Chap. 4, para. 12. Check d.c. conditions as presented in Table 1.

A2 Synchronised output check

8. Carry out the output current balance check described in Chap. 4, para. 11. Change the signal generator frequency and check that the voltage change across

C23 is proportional to the change across R64. Check the components surrounding TR10 and IC29.

Frequency reference divider check

9. Confirm the period of the divider outputs on IC16 pins 6 and 8, the output from pin 6 being the inverse of that on pin 8, Fig. 3e. If these are incorrect the individual IC's may be checked for their respective divisions as shown in Table 3.

TABLE 3 FREQUENCY REFERENCE DIVIDER PERIODS

IC	*Pin No.*	*Period*	*Frequency*	*Remarks*
14	11	1 µs	1 MHz	} via switch AOSL
14	14	1 µs	1 MHz	
14	12	2 µs	500 kHz	
15	11	25 ms	40 Hz	
15	1/12	5 ms	200 Hz	
21	11	10 µs	100 kHz	
22	8	2.5 ms	400 Hz	
22	11	2.5 ms	400 Hz	
23	11	50 µs	20 kHz	
24	11	0.5 ms	2 kHz	
24	1/12	100 µs	10 kHz	

Out-of-lock circuit check

10. Check the 10 Hz phase detector drive pulses on IC25 pins 2 and 3, and also on IC27 pin 4. Check that the weighted outputs 1, 2, 4, 8 are present on pins 1, 9, 8, 11, and that three outputs also appear on IC27 pins 1, 2 and 5. Check the 10 Hz v.r.d. pulse is present on IC27 pin 4. With all IC27 inputs coincident a 10 Hz output will be obtained at pin 6. This in turn triggers the monostable IC28 keeping the OUT-OF-LOCK lamp extinguished.

Variable ratio dividers, dual modulus prescaler and e.c.l./t.t.l. converter check

11. Check the frequency selection on switches SA to SF, which are identical in operation; a short circuit to earth will indicate a '0' in the nines complement code. Switch SG differs only in that it has eleven switch positions and is used in the 10 MHz step selection.

TABLE 4 VRD TRUTH TABLES

Switch No.	*A2 pin no. for b.c.d. code* 1	2	4	8
SA	7	8	9	10
SB	11	12	13	14
SC	15	16	17	18
SD	19	20	21	22
SE	23	24	25	26
SF	27	28	29	30
SG	31	32	33	34

TABLE 4 VRD TRUTH TABLES continued

Setting of SA to SF	*Logic state 1*	*2*	*4*	*8*
9	0	0	0	0
8	1	0	0	0
7	0	1	0	0
6	1	1	0	0
5	0	0	1	0
4	1	0	1	0
3	0	1	1	0
2	1	1	1	0
1	0	0	0	1
0	1	0	0	1

Setting of SG	*Logic state 1*	*2*	*4*	*8*
11	0	0	0	0
10	1	0	0	0
9	0	1	0	0
8	1	1	0	0
7	0	0	1	0
6	1	0	1	0
5	0	1	1	0
4	1	1	1	0
3	0	0	0	1
2	1	0	0	1
1	0	1	0	1
0	1	1	0	1

12. In order that the waveforms in Fig. 1 can be seen on the test oscilloscope ensure that the TF 2016 is at 20 MHz and the TF 2173 is set to 0000300. Failure to obtain any of these waveforms will indicate the area of breakdown.

Note...

The initial 20 MHz input is prescaled to 2 MHz by the action of IC1.

Sample and hold drivers

13. The input to the sample and hold drivers from the reset latch IC12 pin 3 and 4 as shown in Chap. 5, Fig. 3(c) should be checked, and then the following:

(i) IC17 pin 1 : 10 Hz negative-going pulse, duration 0.7 ms (h)
(ii) IC17 pin 6 : 10 Hz positive-going pulse, duration 0.7 ms (h)
(iii) IC18 pin 1 : 10 Hz negative-going pulse, duration 70 µs (i)
(iv) IC18 pin 6 : 10 Hz positive-going pulse, duration 70 µs (i)
(v) IC19 pin 6 : 10 Hz positive-going pulse, duration 0.45 ms (j)
(vi) IC19 pin 1 : 10 Hz negative-going pulse, duration 0.45 ms (j)
(vii) The reset pulse on IC20 pin 6 will only appear should a low frequency selection be made from a previous higher setting, as explained in Chap. 3, para. 27.

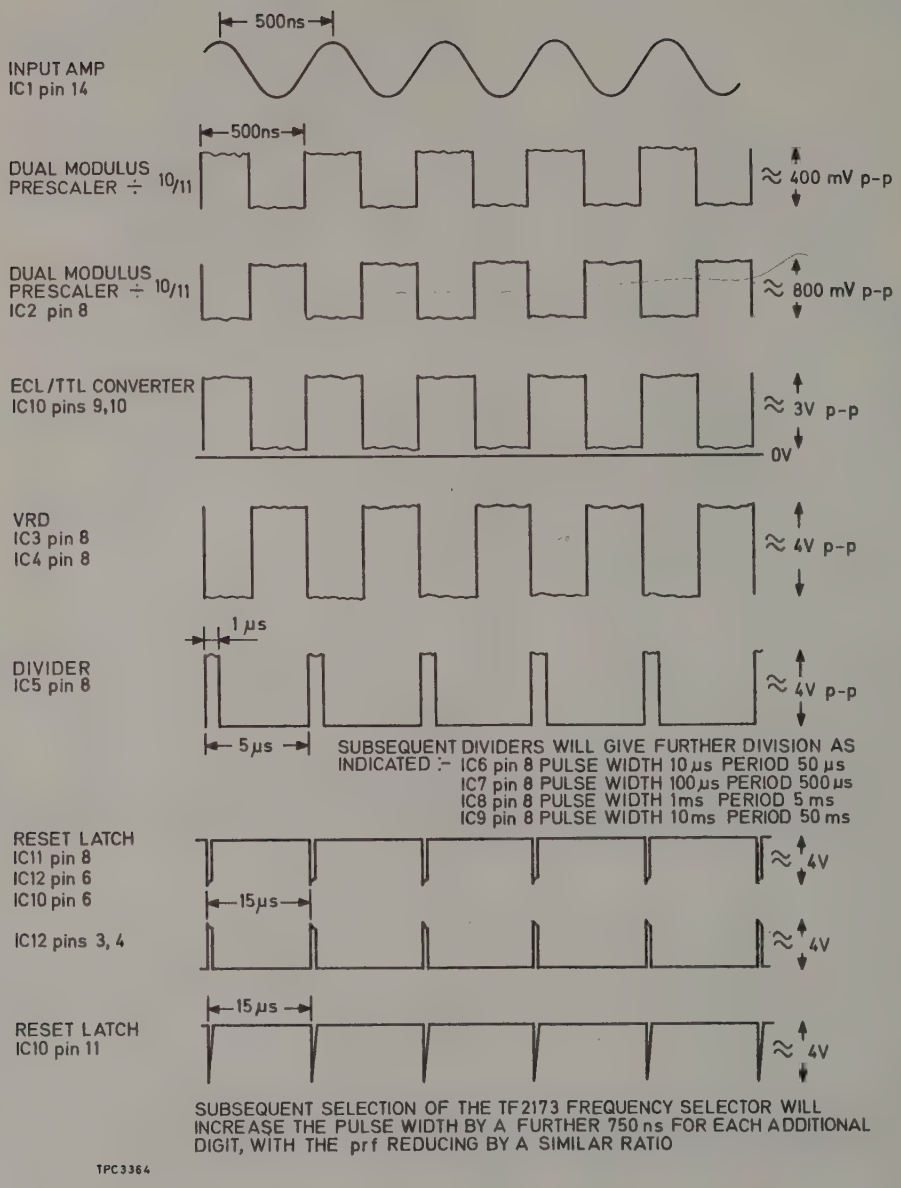

Fig. 1 VRD waveforms

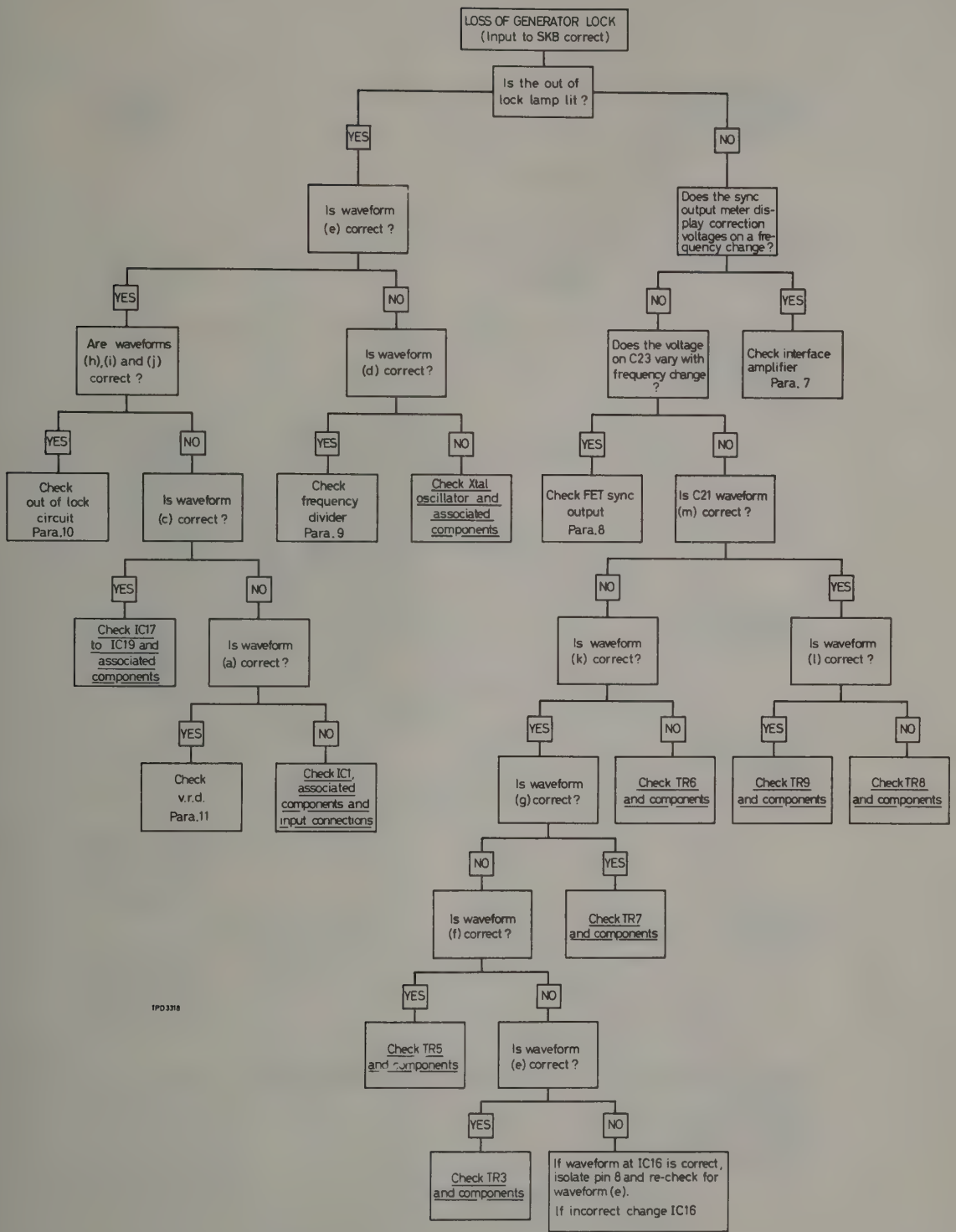

Fig. 2 Fault finding chart

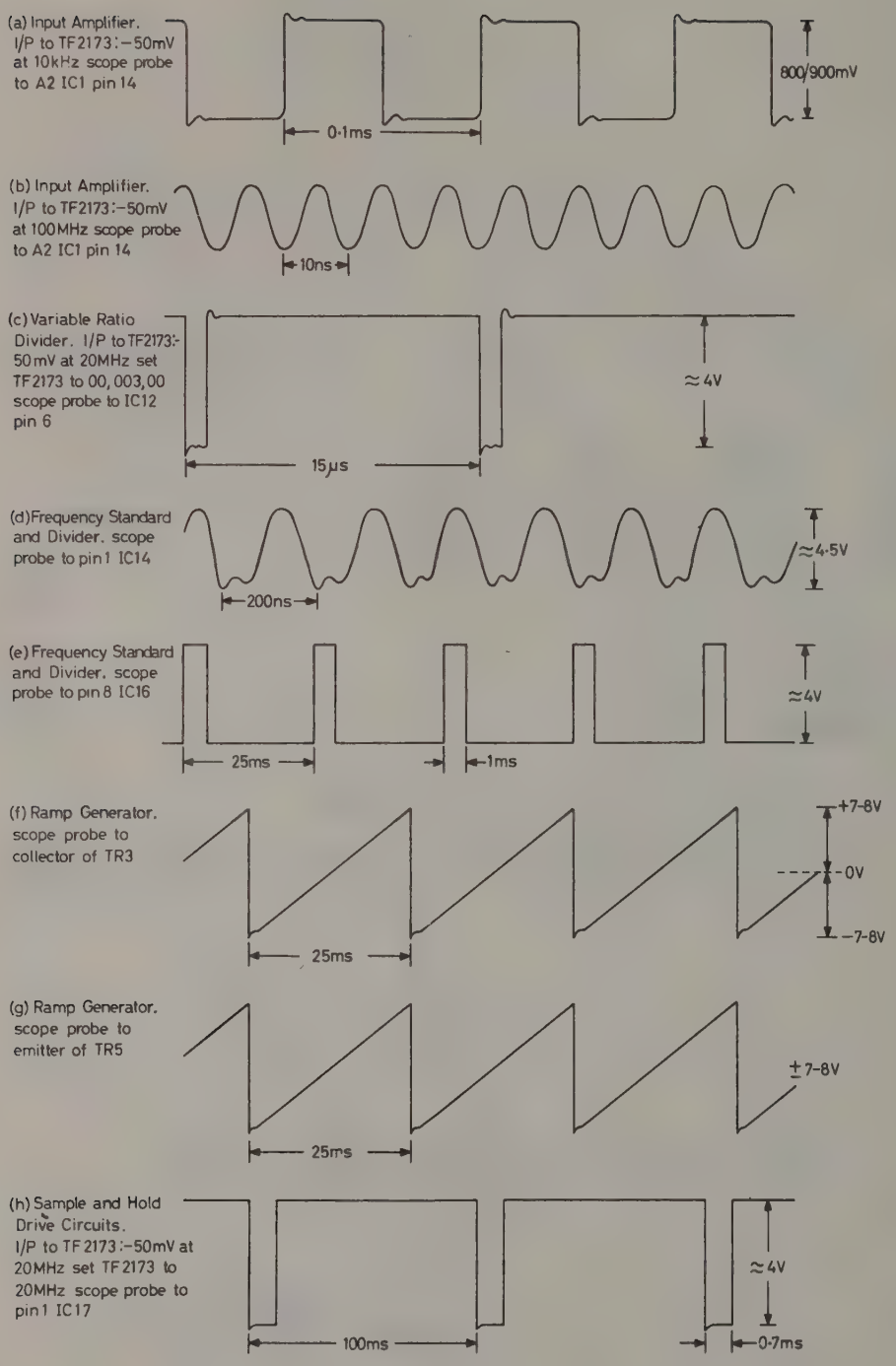
(a) Input Amplifier. I/P to TF2173:-50mV at 10kHz scope probe to A2 IC1 pin 14
800/900mV
0·1ms
(b) Input Amplifier. I/P to TF2173:-50mV at 100MHz scope probe to A2 IC1 pin 14
10ns
(c) Variable Ratio Divider. I/P to TF2173:-50mV at 20MHz set TF2173 to 00,003,00 scope probe to IC12 pin 6
≈4V
15µs
(d) Frequency Standard and Divider. scope probe to pin 1 IC14
≈4·5V
200ns
(e) Frequency Standard and Divider. scope probe to pin 8 IC16
≈4V
25ms
1ms
(f) Ramp Generator. scope probe to collector of TR3
+7·8V
0V
-7·8V
25ms
(g) Ramp Generator. scope probe to emitter of TR5
±7·8V
25ms
(h) Sample and Hold Drive Circuits. I/P to TF2173:-50mV at 20MHz set TF2173 to 20MHz scope probe to pin 1 IC17
≈4V
100ms
0·7ms

Fig. 3 Typical waveforms

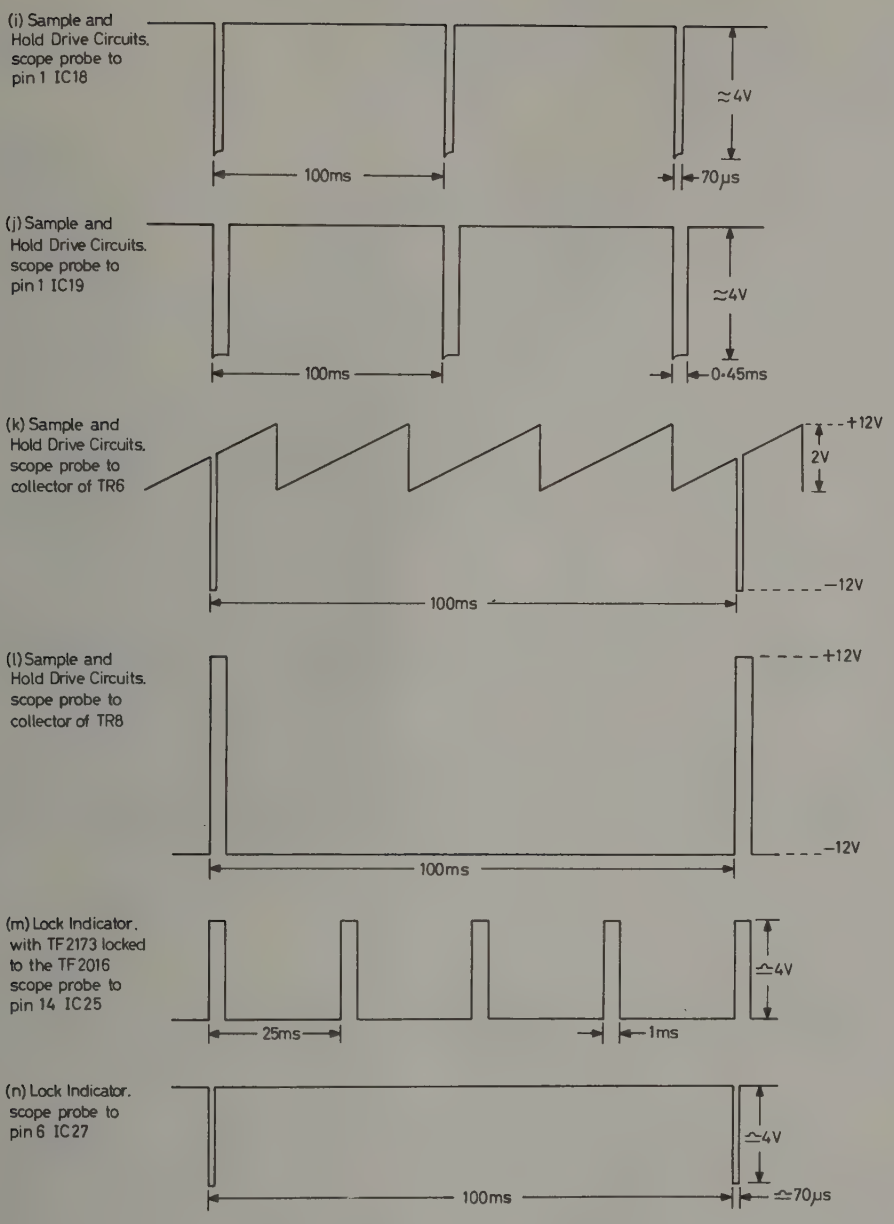
(i) Sample and Hold Drive Circuits. scope probe to pin 1 IC18
≃4V
100ms
70µs
(j) Sample and Hold Drive Circuits. scope probe to pin 1 IC19
≃4V
100ms
0·45ms
(k) Sample and Hold Drive Circuits. scope probe to collector of TR6
+12V
2V
−12V
100ms
(l) Sample and Hold Drive Circuits. scope probe to collector of TR8
+12V
−12V
100ms
(m) Lock Indicator. with TF2173 locked to the TF2016 scope probe to pin 14 IC25
≃4V
25ms
1ms
(n) Lock Indicator. scope probe to pin 6 IC27
≃4V
100ms
≃70µs

Fig. 3 (contd.)

Chapter 6

REPLACEABLE PARTS

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10 Unit A4 - Power supply board
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INTRODUCTION

1. Each sub-assembly or printed circuit board in this instrument has been allocated a unit identification, e.g. A0, A2 etc.

2. The complete component reference carries its unit number as a prefix e.g. A0C3 (capacitor C3 on the main chassis assembly) but for convenience in the text and on circuit diagrams the prefix is not used. However, when ordering replacements or in correspondence the complete component reference must be quoted.

ABBREVIATIONS

3. The components are listed in alphanumerical order of the complete circuit reference and the following abbreviations are used:

C : capacitor
Carb : carbon
Cer : ceramic
D : semiconductor diode
Elec : electrolytic
FS : fuse
IC : integrated circuit (package)
L : inductor
LP : lamp
Max : maximum
ME : meter
Met : metal
Mic : mica
Min : minimum
Ø : feed-through component
Ox : oxide
Pl : plug
Plas : plastic
R : resistor
S : switch
SK : socket
T : transformer
Tant : tantalum
TP : terminal
TR : transistor
Var : variable
W : watts at 70°C
WW : wirewound
† : values selected during test; nominal value listed

COMPONENT VALUES

4. One or more of the components fitted in this instrument may differ from those listed in this chapter for any of the following reasons:

(a) Components indicated by a † have their value selected during test to achieve particular performance limits.

(b) Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the instrument is maintained.

(c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

5. When there is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the instrument.

ORDERING

6. When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required:

(1) Type* and serial number of instrument.

(2) Complete circuit reference.

(3) Description.

(4) MI code number.

* As given on the serial number label at the rear of the instrument; if this is superseded by a model number label, quote the model number instead of the type number.

7. Unit A0 - Main chassis assembly

When ordering, prefix circuit reference with A0.

Circuit ref.	Description	MI code
C1	Cer Ø 0.001µF -20+80% 500V	26373-733K
C2	Cer Ø 0.001µF -20+80% 500V	26373-733K
C3	Cer Ø 0.001µF -20+80% 500V	26373-733K
C7	Cer Ø 0.001µF -20+80% 500V	26373-733K
C8	Cer Ø 0.001µF -20+80% 500V	26373-733K
C9	Cer Ø 0.001µF -20+80% 500V	26373-733K
C10	Cer Ø 0.001µF -20+80% 500V	26373-733K
C11	Cer Ø 0.001µF -20+80% 500V	26373-733K
C12	Cer Ø 0.001µF -20+80% 500V	26373-733K
C13	Cer Ø 0.001µF -20+80% 500V	26373-733K
C14	Cer Ø 0.001µF -20+80% 500V	26373-733K
C15	Cer Ø 0.001µF -20+80% 500V	26373-733K
C16	Cer Ø 0.001µF -20+80% 500V	26373-733K
C17	Cer Ø 0.001µF -20+80% 500V	26373-733K
C18	Cer Ø 0.001µF -20+80% 500V	26373-733K
C19	Cer Ø 0.001µF -20+80% 500V	26373-733K
C20	Cer Ø 0.001µF -20+80% 500V	26373-733K
C21	Cer Ø 0.001µF -20+80% 500V	26373-733K
C22	Elec 4.7µF -20+80% 63V	26415-801M
C23	Elec 2200µF -10+100% 40V	26426-086D
C24	Elec 2200µF -10+100% 40V	26426-086D
C25	Elec 4700µF -10+50% 16V	26426-091P
C26	Elec 1000µF -20+100% 63V	26426-081F
C27	Tant 0.47µF 20% 35V	26486-207L
C28	Tant 0.47µF 20% 35V	26486-207L
C29	Plas 0.47µF 10% 100V	26582-215H
C30	Tant 0.47µF 20% 35V	26486-207L
C31	Tant 0.47µF 20% 35V	26486-207L
C32	Tant 0.47µF 20% 35V	26486-207L
C33	Elec 470µF -20+100% 25V	26415-822G
C35	Elec 220µF -20+100% 10V	26415-817J
C36	Cer 0.1µF -25+50% 100V	26383-031S
C37	Cer 0.1µF -25+50% 100V	26383-031S
C38	Elec 4.7µF -20+80% 63V	26415-801M
C39	Cer 0.1µF -25+50% 100V	26383-031S
C40	Plas 0.15µF 10% 100V	26582-212K
D1	LED (on/off indicator)	28624-104W
D2	LED (out of lock indicator)	28624-104W
D3	1N4148	28336-676J
FS1	250mA (slow blow) 190-264V	23411-055P
	or 500mA (slow blow) 95-130V	23411-056X

Circuit ref.	Description	MI code
	Unit A0 - Main chassis assembly (contd.)	
	Fuseholder	23416-191C
	Fuseholder cover	37575-121B
IC1	Regulator 12V µA7812	28461-708V
IC2	Regulator 5V LM309K	28461-704L
IC3	Regulator 24V µA7824	28461-710G
L1	Filter coil 6µH	44290-023M
L2	Filter coil 6µH	44290-023M
L3	Filter coil 10µH	23642-555G
L4	Filter coil 10µH	23642-555G
L5	Filter coil 10µH	23642-555G
L6	Filter coil 10µH	23642-555G
L7	Filter coil 6µH	44290-023M
L8	Filter coil 6µH	44290-023M
L9	Filter coil 10µH	23642-555G
L10	Filter coil 10µH	23642-555G
L11	Filter coil 10µH	23642-555G
L12	Filter coil 10µH	23642-555G
PLA	Mains connector	23423-158T
ME1	Meter	44559-011Z

Circuit ref.	Description	MI code
	Meter board assembly comprising :	44828-286W
D1	1N4148	28336-676J
R1	Met film 200Ω 2% 1/4W	24773-256S
R2	Met film 200Ω 2% 1/4W	24773-256S
R3	Met film 100kΩ 2% 1/4W	24773-321L
RV1	Var cermet 1kΩ 10% 1/2W	25711-503F
R2	Met film 130kΩ 2% 1/4W	24773-324G
SA	Frequency switch Hz x 100	44340-052X
SB	Frequency switch kHz	44340-052X
SC	Frequency switch kHz x 10	44340-052X
SD	Frequency switch kHz x 100	44340-052X
SE	Frequency switch MHz	44340-052X
SF	Frequency switch MHz x 10	44340-052X
SG	Frequency switch MHz x 100	44340-117T
SH	Supply switch DPDT	23462-258L
SJ	Voltage selector switch 230V/115V	23467-155G
SK	Lock switch DPDT	23462-258L
SL	1 MHz - STD switch DPDT	23462-331L
SKB	Bulkhead Jack TNC 50Ω	23444-741Z
SKC	Bulkhead socket BNC 50Ω	23443-443K
SKD	Bulkhead socket BNC 50Ω	23443-443K

Circuit ref.	Description	MI code
	Unit A0 - Main chassis assembly (contd.)	
T1	Mains transformer	43490-015N
TR1	Transistor MJ491	28435-876Z
8.	Unit A2 - Synchronizer board	
	When ordering, prefix circuit reference with A2.	
	Complete board	44827-808N
C1	Cer 0.1µF -25+50% 30V	26383-031S
C2	Tant 4.7µF 20% 35V	26486-219P
C3	Tant 4.7µF 20% 35V	26486-219P
C4	Tant 4.7µF 20% 35V	26486-219P
C5	Tant 4.7µF 20% 35V	26486-219P
C6	Cer 0.1µF -25+50% 30V	26383-031S
C7	Cer 0.1µF -25+50% 30V	26383-031S
C8	Cer 0.1µF -25+50% 30V	26383-031S
C9	Cer 0.01µF -20+80% 100V	26383-055L
C10	Plas 0.1µF 10% 100V	26582-211B
C11	Plas 0.01µF 10% 250V	26582-202T
C12	Plas 0.068µF 10% 100V	26582-224J
C13	Elec 220µF -20+100% 10V	26415-817J
C14	Elec 47µF -20+100% 10V	26415-809E
C15	Tant 0.47µF 20% 35V	26486-207L
C16	Plas 0.22µF 10% 100V	26582-226G
C17	Elec 220µF -20+100% 10V	26415-817J
C18	Plas 0.22µF 10% 100V	26582-226G
C19	Plas 22pF ±2pF 160V	26516-088K
C20	Plas 0.22µF 10% 100V	26582-226G
C21	Plas 1.0µF 10% 100V	26582-217U
C22	Plas 22pF ±2pF 160V	26516-088K
C23	Plas 0.47µF 10% 100V	26582-215H
C24	Elec 220µF -20+100% 25V	26415-818F
C25	Elec 220µF -20+100% 25V	26415-818F
C26	Cer 0.01µF -20+80% 100V	26383-055L
C27	Cer 0.01µF -20+80% 100V	26383-055L
C28	Cer 0.01µF -20+80% 100V	26383-055L
C29	Cer 0.01µF -20+80% 100V	26383-055L
C30	Cer 0.01µF -20+80% 100V	26383-055L
C31	Cer 0.01µF -20+80% 100V	26383-055L
C32	Cer 0.01µF -20+80% 100V	26383-055L
C33	Cer 0.01µF -20+80% 100V	26383-055L
C34	Cer 0.01µF -20+80% 100V	26383-055L
C35	Cer 0.01µF -20+80% 100V	26383-055L
C36	Cer 0.01µF -20+80% 100V	26383-055L
C37	Cer 0.01µF -20+80% 100V	26383-055L
C38	Cer 0.01µF -20+80% 100V	26383-055L
C39	Cer 0.01µF -20+80% 100V	26383-055L
C40	Cer 0.01µF -20+80% 100V	26383-055L

Circuit ref.	Description	MI code
	Unit A2 - Synchronizer board (contd.)	
C41	Cer 0.01µF -20+80% 100V	26383-055L
C42	Cer 0.1µF -25+50% 30V	26383-031S
D1	1N4148	28336-676J
D2	1N4148	28336-676J
D3	1N4148	28336-676J
D4	Zener 1S6006	28371-549T
D5	1N4148	28336-676J
D6	1N4148	28336-676J
D7	1N4148	28336-676J
D8	1N4148	28336-676J
D9	1N4148	28336-676J
D10	Zener 8.2V	28371-673Y
D11	1N4148	28336-676J
D12	1N4148	28336-676J
D13	1N4148	28336-676J
D14	1N4148	28336-676J
D15	1N4148	28336-676J
D16	1N4148	28336-676J
D17	BA182	28335-677K
IC1	MC 10216	28469-169J
IC2	SP 8641B	28464-013V
IC3	82S90	28464-010J

Circuit ref.	Description	MI code
IC4	74196	28464-004Y
IC5	74196	28464-004Y
IC6	74196	28464-004Y
IC7	74196	28464-004Y
IC8	74196	28464-004Y
IC9	N8291	28464-103H
IC10	74S00N	28466-331D
IC11	7430	28466-325V
IC12	74S00N	28466-331D
IC13	7430	28466-325V
IC14, IC15	7490	28464-002E
IC16	7420	28466-324G
IC17	74121	28468-402S
IC18	74121	28468-402S
IC19	74121	28468-402S
IC20	74122	28468-303T
IC21	7490	28464-002E
IC22	7490	28464-002E
IC23	7490	28464-002E
IC24	7490	28464-002E
IC25	7490	28464-002E
IC26	7400	28466-321L
IC27	7420	28466-324G
IC28	74122	28468-303T
IC29	µA741	28461-304T

Unit A2 - Synchronizer board (contd.)

Circuit ref.	Description	MI code
R1	Met film 100Ω 2% 1/4W	24773-249J
R2	Met film 1kΩ 2% 1/4W	24773-273A
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Met film 510Ω 2% 1/4W	24773-266C
R5	Met film 510Ω 2% 1/4W	24773-266C
R6	Met film 510Ω 2% 1/4W	24773-266C
R7	Met film 510Ω 2% 1/4W	24773-266C
R8	Met film 510Ω 2% 1/4W	24773-266C
R9	Var. cermet 1kΩ 10% 1/2W	25711-544T
R10	Met film 510Ω 2% 1/4W	24773-266C
R11	Met film 510Ω 2% 1/4W	24773-266C
R12	Met film 240Ω 2% 1/4W	24773-258D
R13	Met film 270Ω 2% 1/4W	24773-259T
R14, R15	Met film 560Ω 2% 1/4W	24773-267R
R16	Met film 180Ω 2% 1/4W	24773-255V
R17	Met film 10kΩ 2% 1/4W	24773-297M
R18	Met film 10kΩ 2% 1/4W	24773-297M
R19	Met film 10kΩ 2% 1/4W	24773-297M
R20	Met film 10kΩ 2% 1/4W	24773-297M
R21	Met film 10kΩ 2% 1/4W	24773-297M
R22	Met film 10kΩ 2% 1/4W	24773-297M
R23	Met film 10kΩ 2% 1/4W	24773-297M
R24	Met film 10kΩ 2% 1/4W	24773-297M
R25	Met film 10kΩ 2% 1/4W	24773-297M
R26	Met film 10kΩ 2% 1/4W	24773-297M
R27	Met film 10kΩ 2% 1/4W	24773-297M
R28	Met film 10kΩ 2% 1/4W	24773-297M
R29	Met film 10kΩ 2% 1/4W	24773-297M
R30	Met film 10kΩ 2% 1/4W	24773-297M
R31	Met film 10kΩ 2% 1/4W	24773-297M
R32	Met film 10kΩ 2% 1/4W	24773-297M
R33	Met film 10kΩ 2% 1/4W	24773-297M
R34	Met film 10kΩ 2% 1/4W	24773-297M
R35	Met film 10kΩ 2% 1/4W	24773-297M
R36	Met film 10kΩ 2% 1/4W	24773-297M
R37	Met film 10kΩ 2% 1/4W	24773-297M
R38	Met film 10kΩ 2% 1/4W	24773-297M
R39	Met film 10kΩ 2% 1/4W	24773-297M
R40	Met film 10kΩ 2% 1/4W	24773-297M
R41	Met film 10kΩ 2% 1/4W	24773-297M
R42	Met film 10kΩ 2% 1/4W	24773-297M
R43	Met film 10kΩ 2% 1/4W	24773-297M
R44	Met film 10kΩ 2% 1/4W	24773-297M
R45	Met film 4.7kΩ 2% 1/4W	24773-289W
R46	Met film 2.2kΩ 2% 1/4W	24773-281Y
R47	Var. cermet 220Ω 10% 1/2W	25711-546X
R48	Met film 2.2kΩ 2% 1/4W	24773-281Y

Circuit ref.	Description	MI code
	Unit A2 - Synchronizer board (contd.)	
R49	Met film 1kΩ 2% 1/4W	24773-273A
R50	Met film 10kΩ 2% 1/4W	24773-297M
R51	Met film 10kΩ 2% 1/4W	24773-297M
R52	Met film 10kΩ 2% 1/4W	24773-297M
R53	Met film 10kΩ 2% 1/4W	24773-297M
R54	Met film 4.7kΩ 2% 1/4W	24773-289W
R55	Met film 8.2kΩ 2% 1/4W	24773-295P
R56	Var. cermet 2.2kΩ 10% 1/2W	25711-547M
R57	Met film 1kΩ 2% 1/4W	24773-273A
R58	Met film 2.2kΩ 2% 1/4W	24773-281Y
R59	Met film 15kΩ 2% 1/4W	24773-301P
R60	Met film 10kΩ 2% 1/4W	24773-297M
R61	Met film 15kΩ 2% 1/4W	24773-301P
R62	Met film 10kΩ 2% 1/4W	24773-297M
R63	Met film 100kΩ 2% 1/4W	24773-321L
R64	Met film 22Ω 2% 1/4W	24773-233M
R65	Met film 390Ω 2% 1/4W	24773-263P
R66, R67	Met film 1kΩ 2% 1/4W	24773-273A
R68	Met film 47kΩ 2% 1/4W	24773-313H
R69	Met film 10kΩ 2% 1/4W	24773-297M
R70	Met film 150Ω 2% 1/4W	24773-253F
R71	Met film 1kΩ 2% 1/4W	24773-273A
R72, R73	Met film 470Ω 2% 1/4W	24773-265M
R74	Met film 82Ω 2% 1/4W	24773-247N
R75, R76	Met film 470Ω 2% 1/4W	24773-265M
TR1	Transistor MPS-L08	28431-767E
TR2	Transistor BC107	28455-437L
TR3	Transistor BC107	28455-437L
TR4	Transistor f.e.t. BFW11	28459-012W
TR5	Transistor BCY71	28435-235L
TR6	Transistor BC107	28455-437L
TR7	Transistor f.e.t. BF244B	28459-011S
TR8	Transistor BC107	28455-437L
TR9	Transistor f.e.t. BF244B	28459-011S
TR10	Transistor dual f.e.t. E430	28459-031E
TR11	Transistor BC107	28455-437L
	5 MHz Crystal oscillator	28313-865G

9. Unit A3 - Interface amplifier board

When ordering, prefix circuit reference with A3.

	Complete board	44827-305W
APC1	Analogue photo coupler	44990-097Y

Circuit ref.	Description	MI code
	Unit A3 - Interface amplifier board (contd.)	
C1	Elec 47µF -20+100% 40V	26415-810Z
C2	Plas 1µF 10% 100V	26582-217U
D1	1N4148	28336-676J
D3	1N4148	28336-676J
D4	1N4148	28336-676J
R1	Met film 3.9kΩ 2% 1/4W	24773-287V
R2	Met film 220Ω 2% 1/4W	24773-257W
R3	Met film 68Ω 2% 1/4W	24773-245U
R4	Met film 15kΩ 2% 1/4W	24773-301P
R5	Met film 62kΩ 2% 1/4W	24773-316Y
R6	Met film 4.3kΩ 2% 1/4W	24773-288S
R7	Met film 4.7kΩ 2% 1/4W	24773-289W
R8	Met film 4.7kΩ 2% 1/4W	24773-289W
R9	Met film 100kΩ 2% 1/4W	24773-321L
R10	Met film 20kΩ 2% 1/4W	24773-304C
R11	Met film 39kΩ 2% 1/4W	24773-311A
R12	Met film 100kΩ 2% 1/4W	24773-321L
R13*†	Carb 470kΩ 5% 1/8W	24311-937A
R14	Met film 20kΩ 2% 1/4W	24773-304C
R15	Met film 39kΩ 2% 1/4W	24773-311A
R16	Met film 100kΩ 2% 1/4W	24773-321L
R17*†	Carb 470kΩ 5% 1/8W	24311-937A
TR1	BCY71	28435-235L
TR2	BCY71	28435-235L
TR3	BC109	28452-777K
TR4	BC109	28452-777K
TR5	BCY71	28435-235L
TR6	BC109	28452-777K
	Transistor pad	28488-115L

* Only one SIC resistor, either R13 or R17, is required to be changed to obtain balance - see Chap. 4, para. 12(5).

10. Unit A4 - Power supply board

When ordering, prefix circuit reference with A4.

	Complete board	44827-306D
C1	Elec 4.7µF -20+100% 63V	26415-801M
C2	Elec 470µF -20+100% 25V	26415-822G
D1	1N4004	28357-028K
D2	1N4004	28357-028K

Circuit ref.	*Description*	*MI code*
	Unit A4 - Power supply board (contd.)	
D3	1N4004	28357-023K
D4	1N4004	28357-028K
D5	1N5401	28355-723N
D6	1N5401	28355-723N
D7	1N5401	28355-723N
D8	1N5401	28355-723N
D9	1N4004	28357-028K
D10	1N4004	28357-028K
D11	1N4004	28357-028K
D12	1N4004	28357-028K
D13	Zener Z5B18	28372-583Z
IC1	Operational amplifier μA741	28461-304T
RL1	Relay	23486-427A
R1	Met ox 390Ω 2% 1/2W	24573-063N
R2	Met ox 330Ω 2% 1/2W	24573-061U
R3	WW Var. 47Ω 10% 1W	25811-011J
R4	Met ox 470Ω 2% 1/2W	24573-065J
R5	Met ox 10kΩ 2% 1/2W	24573-097J
R6	Met ox 10kΩ 2% 1/2W	24573-097J

11. Mechanical parts

Order without prefix.

Note ...

Item Nos refer to Fig. 1. Screws, nuts and washers shown in Fig. 1 are not normally supplied with their associated components: where such fasteners are of a special type these are listed and may be ordered separately.

Fig. 1 Item	*Description*	*MI code*
1	Top cover excluding handle	41690-100G
2	Retaining clip (1 of 2) included in item 1	35418-311J
3	Protective clip (1 of 2)	37553-506Y
	Handle assembly comprising:-	
4	Plastic section	22315-575F
5	Liner (1 of 2)	22315-572N
6	End cap (1 of 2)	22315-573L
7	Special nut (1 of 2)	33900-120K
8	Bottom cover	35900-946K
9	Protective clip (1 of 2)	37553-506Y

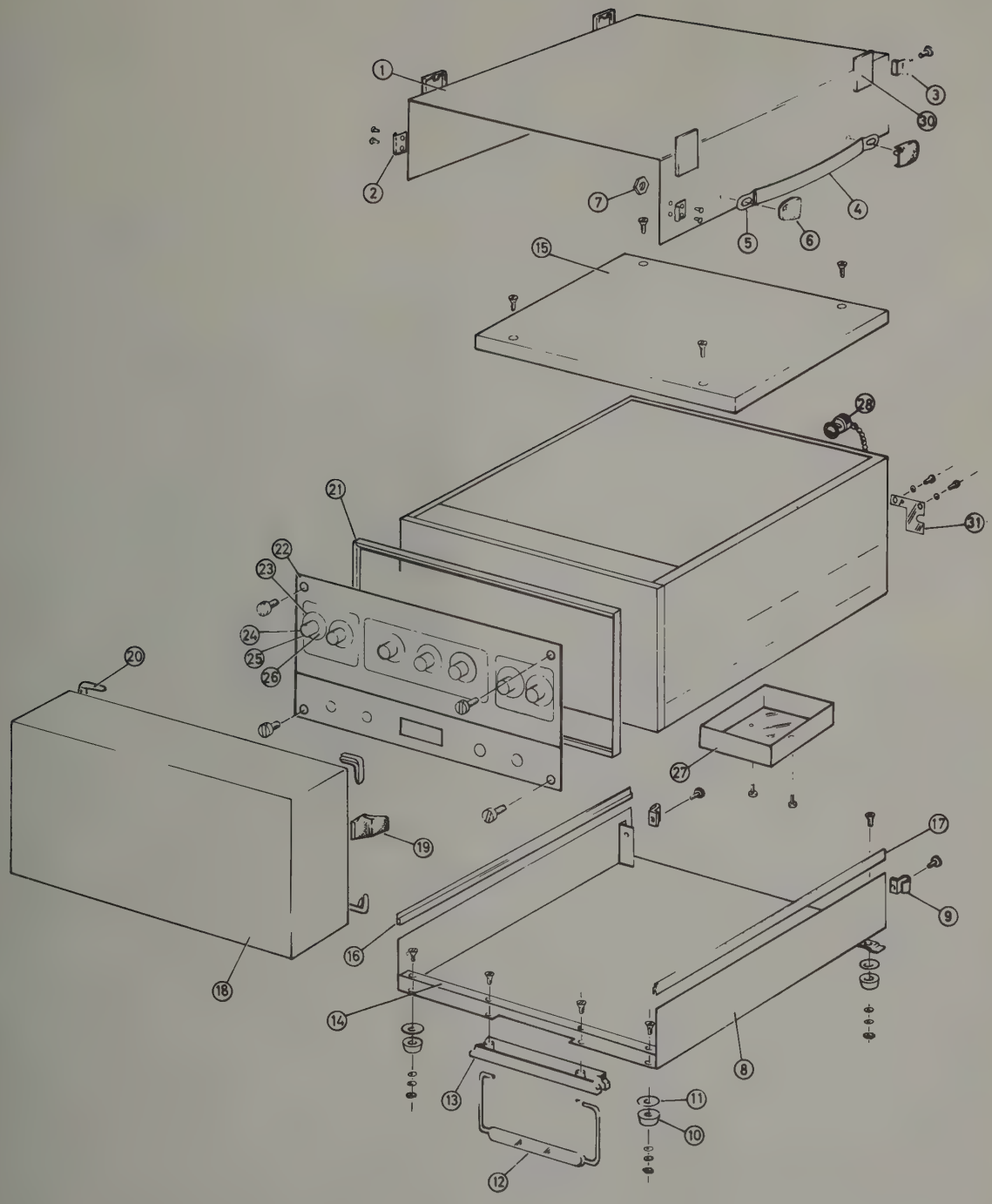

Fig. 1 Mechanical parts

Fig. 1

Item	*Description*	*MI code*
10	Foot (1 of 4)	22315-604E
11	Special washer	33900-438J
	Handle assembly comprising:-	
12	Handle	37587-925L
13	Attachment	37588-110B
14	Strip	21851-463E
15	RF box lid	41690-068P
16	Trim (left side)	34900-191Z
17	Trim (right side)	34900-192H
18	Protective cover, including catches	41690-102S
19	Catch (1 of 2)	22315-102V
20	Corner pad (1 of 4)	37575-123A
21	Surround	41511-018K
22	Front panel fascia	35901-864A
	Frequency switch (seven) comprising:-	
23	Knob	22318-333W
24	Knob cap	22318-334D
25	Dial	22318-335T
26	Stator	22318-336P
27	Filter lid	41690-016H
28	Cap and chain BNC	23443-591L
30	Case clip (1 of 4)	23315-098V
31	Locking plate for mains selector	34444-116Y

Chapter 7

CIRCUIT DIAGRAMS

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Para.
1 Circuit notes
1 Component values
2 Symbols

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1 Main chassis : A0, with A3 and A4 3
2 Component layout : A2 4
3 Synchronizer board : A2 ... ... 5/6

CIRCUIT NOTES

Component values

1. Resistors : no suffix = ohms, k = kilohms, M = megohms.
Capacitors : no suffix = microfarads, p = picofarads.
Inductors : no suffix = henrys, m = millihenrys, μ = microhenrys.
† SIC : value selected during test, nominal value shown.

Symbols

2. Symbols are based on the provisions of BS 3939.

SUPPLY etc. external front or rear panel marking

tag on printed board

A2 unit identification number

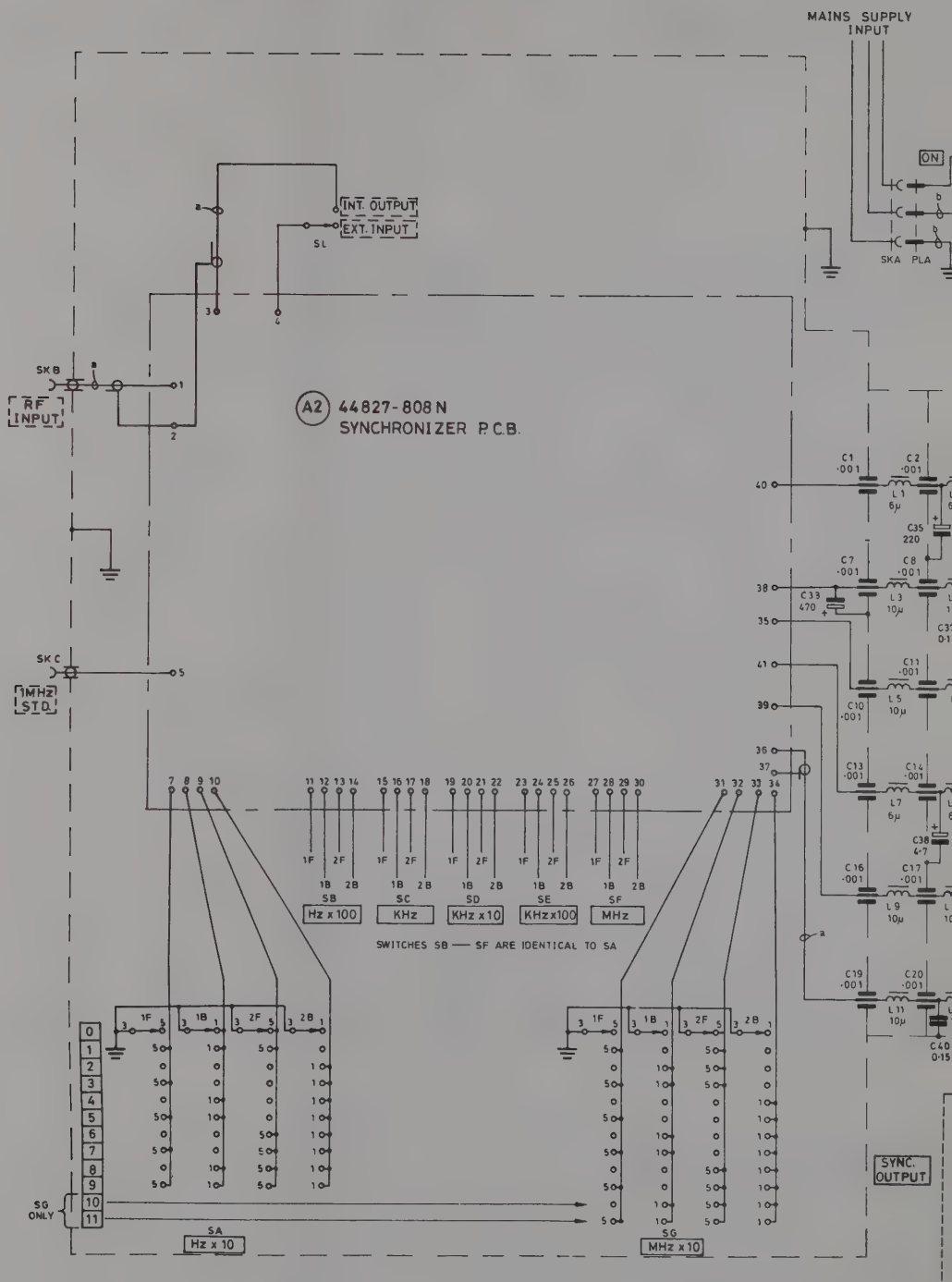
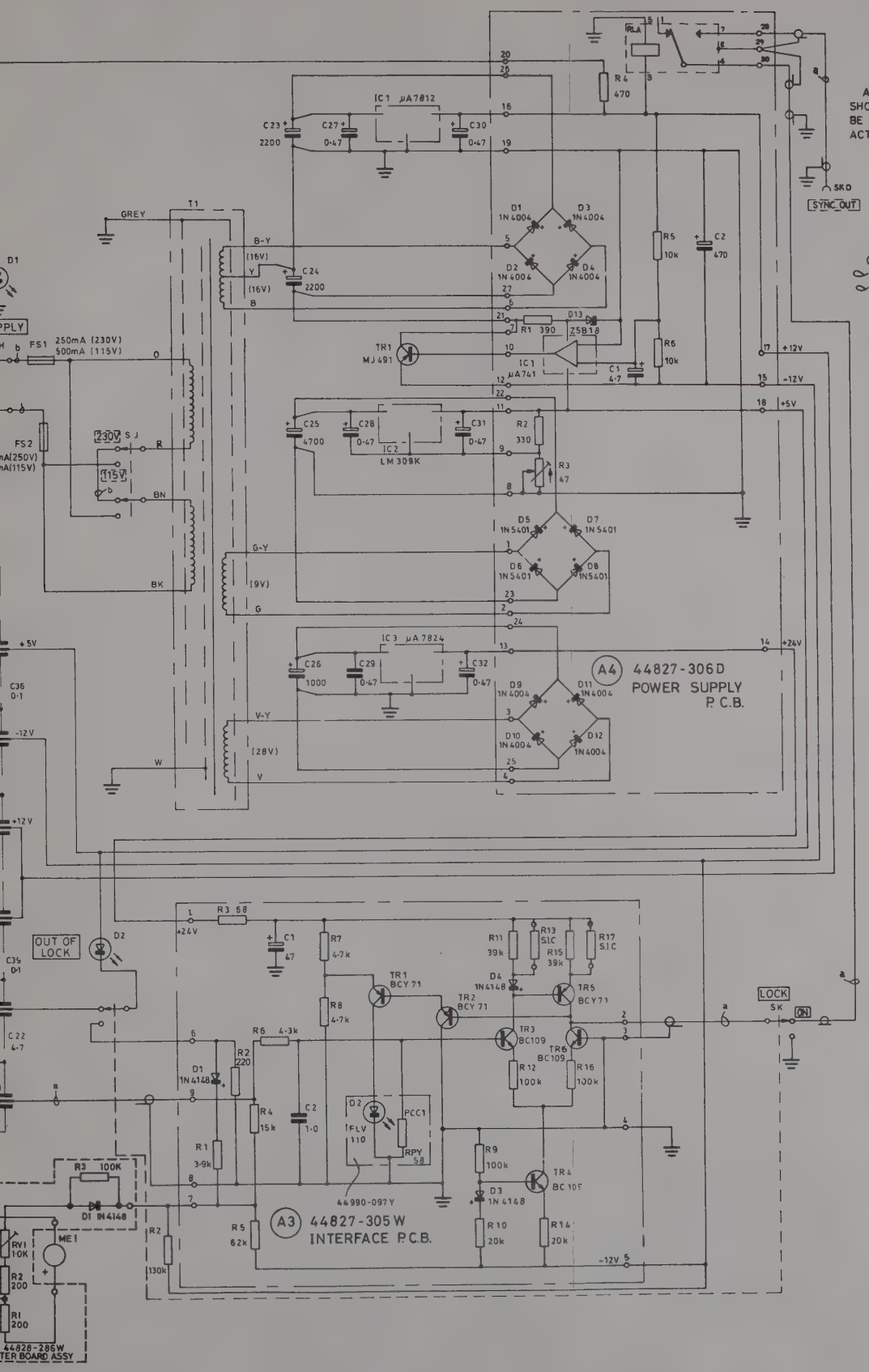


Fig. 1

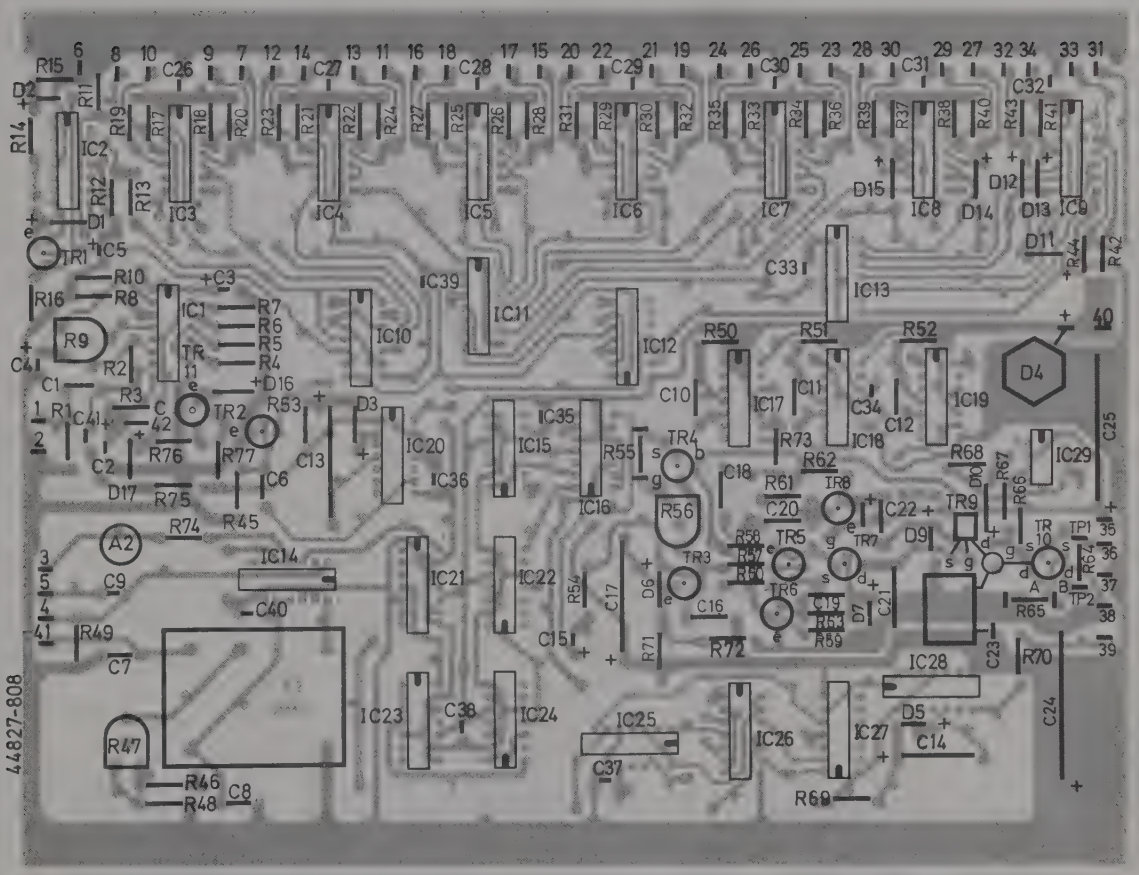
SZ52173-900M Issue 6

Main chassis: A

Aug. 78 (Am.1)



with A3 and A4



Viewed from wiring side

Fig. 2

Component layout : A2

Fig.2

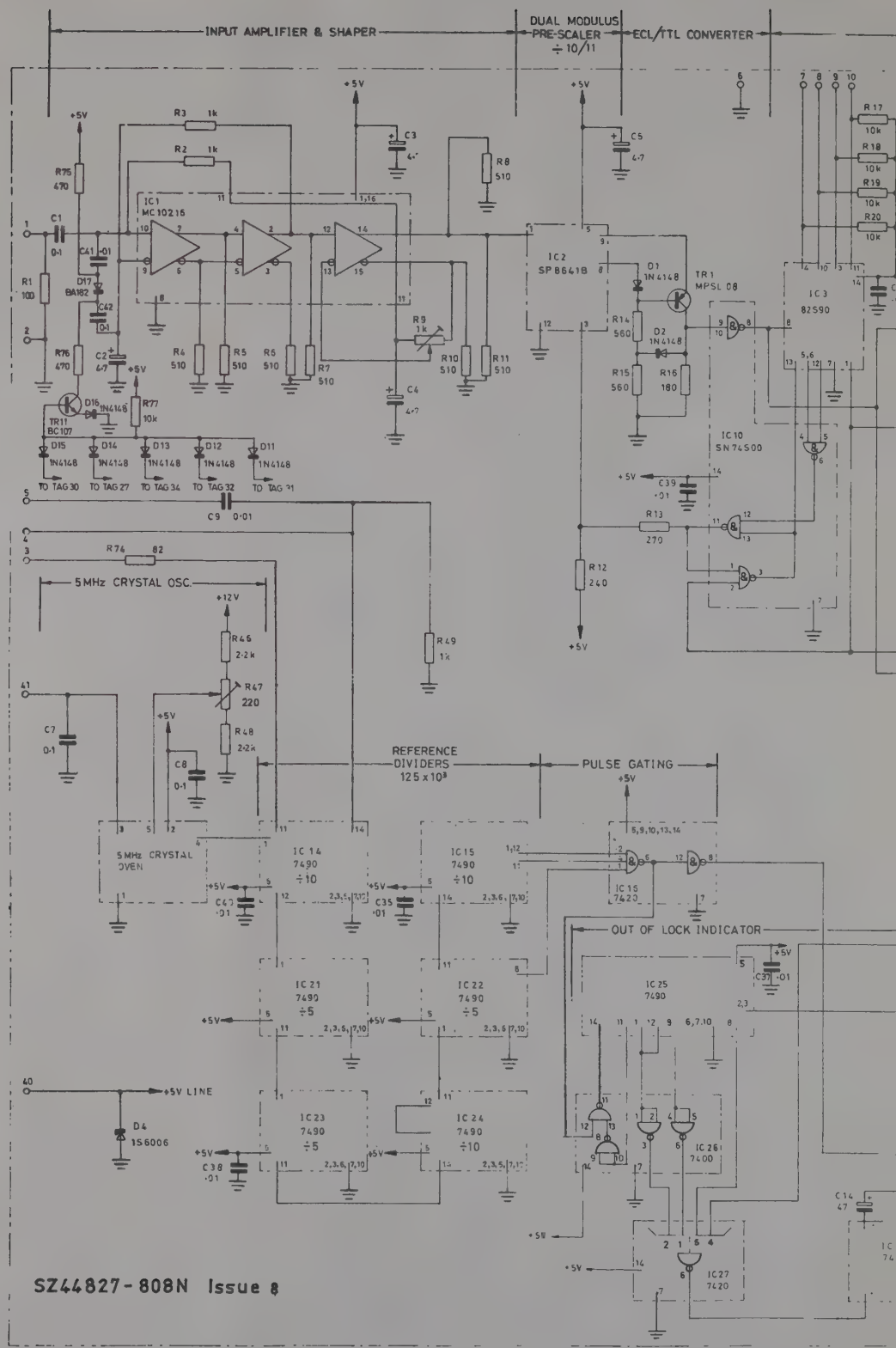
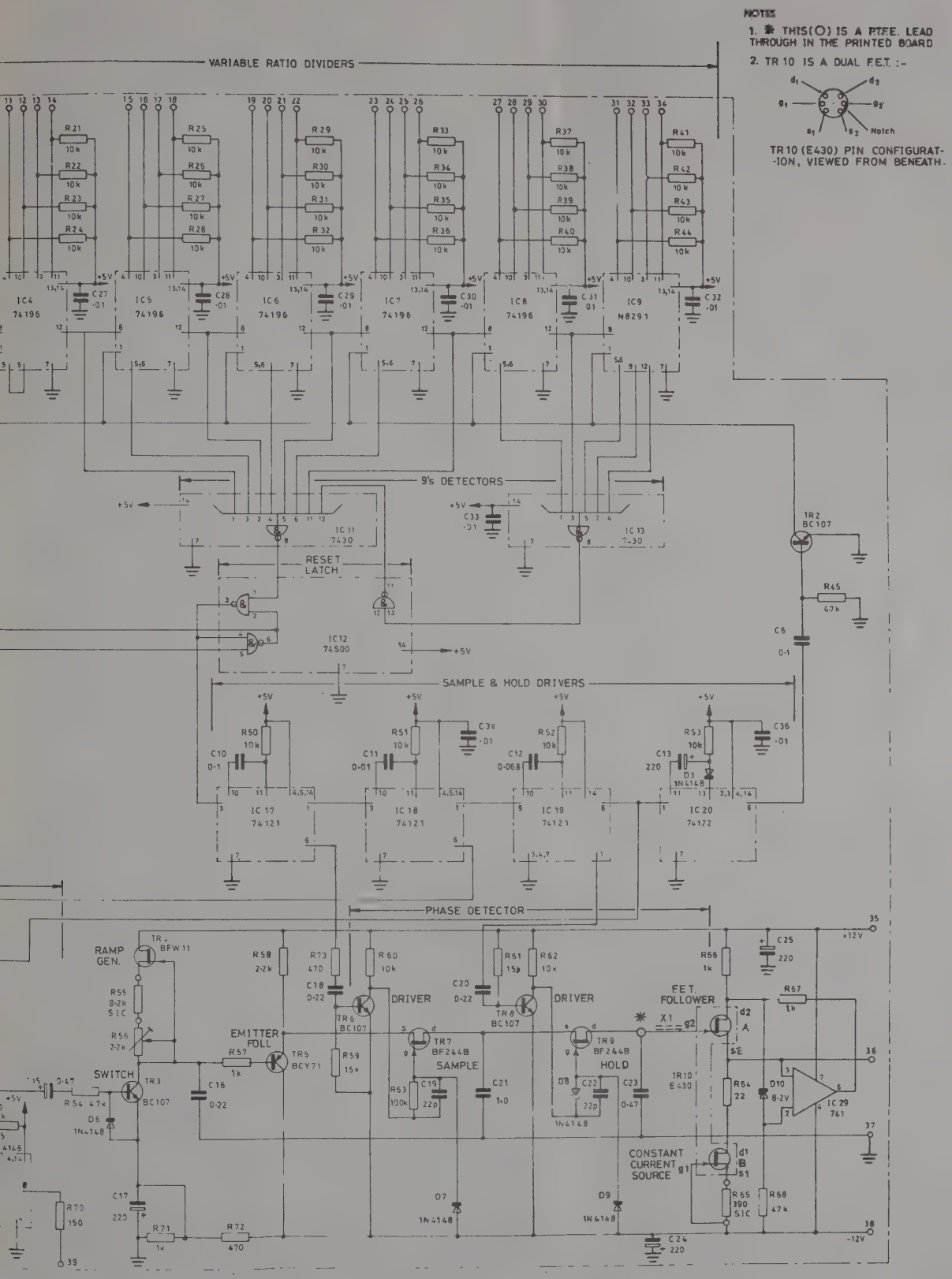

INPUT AMPLIFIER & SHAPER
DUAL MODULUS PRE-SCALER ÷10/11
ECL/TTL CONVERTER
IC1 MC10216
IC2 SP8641B
IC3 82S90
IC10 SN74S00
TR1 MPSL08
TR11 BC107
D1 1N4148
D2 1N4148
D4 1S6006
D15 1N4148
D14 1N4148
D13 1N4148
D12 1N4148
D11 1N4148
TO TAG 30
TO TAG 27
TO TAG 34
TO TAG 32
TO TAG 31
5MHz CRYSTAL OSC.
5MHz CRYSTAL OVEN
REFERENCE DIVIDERS 125 x 10³
PULSE GATING
IC14 7490 ÷10
IC15 7490 ÷10
IC16 7420
IC21 7490 ÷5
IC22 7490 ÷5
IC23 7490 ÷5
IC24 7490 ÷10
IC25 7490
IC26 7400
IC27 7420
OUT OF LOCK INDICATOR
+5V LINE
SZ44827-808N Issue 8

Fig. 3

Synch



nizer board : A2

Fig.3

Chap.7

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